30-Watt Transistor Power Supply

JULY 1958

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

Horizontal Ringing—
Causes and Cures

■

Build a 1-Tube
Audio Vtvm

■

Electronic Boat Horn
and
Low-Power Loud Hailer

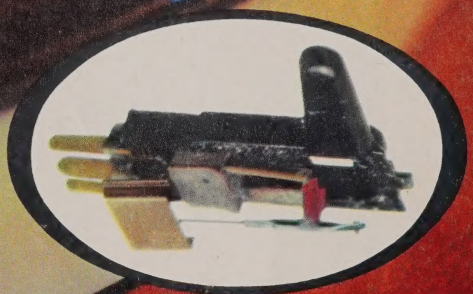
■

How to Improve
Your All-Wave Radio

■

How Stereo Discs
Work

(See page 26)



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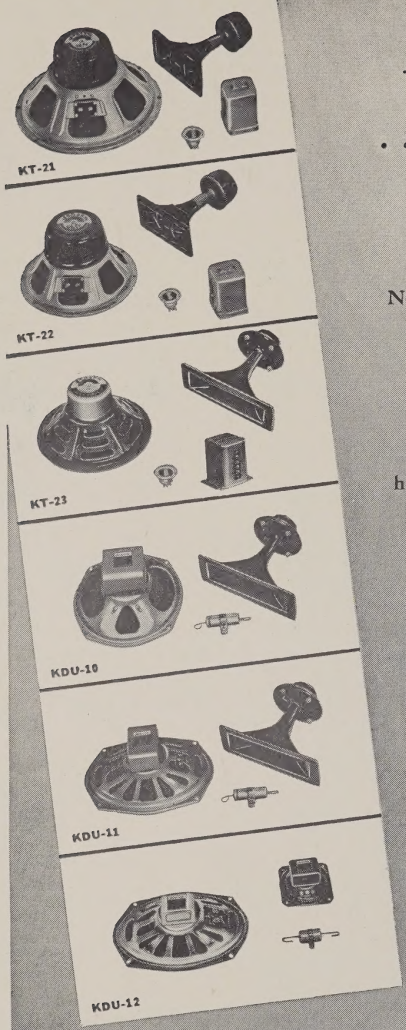

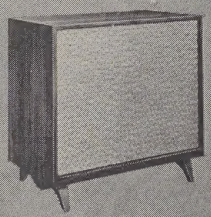

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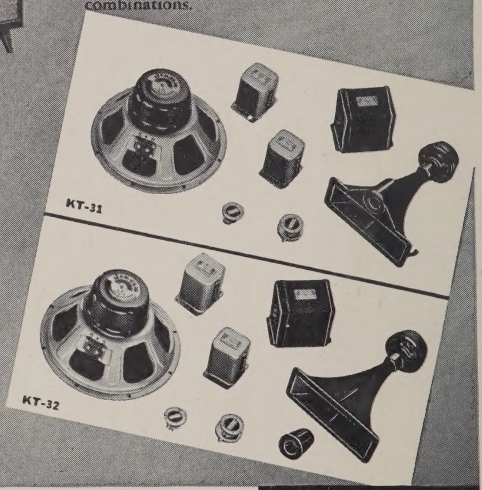

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Type	3-way Imperial	3-way Tri-plex	2-way Concerto-15	2-way Concerto-12	2-way Contemporary	2-way Duette or Contemporary	2-way Automobile or Duette Table	
Frequency Range†††	25-UHL	30-UHL	30-15,000	30-15,000	40-15,000	50-15,000	50-15,000	55-13,000
Power Rating (Watts)	35	35	30	25	20	20	20	15
Impedance (Ohms)	16	16	16	16	16	8	4	4
Components:								
L-F ("Woofer")	P15-LL*	P15-LL	P15-LL	P12-NL	P12-RL	P8-RL	P69-RL†	69J10†
M-F (Mid-Range)	RP-201	RP-201	.....	.....	.....	.....	.....	.....
H-F ("Tweeter" or "Supertweeter")	RP-302	RP-302	RP-102	RP-102	RP-103	RP-103	RP-103	P35-VH
Networks	A-61; A-402	A-61; A-402	A-204	A-204	A-204	Capacitor	Capacitor	Capacitor
Controls	**	ST-917; ST-901	ST-901	ST-901	ST-901	.....	.....	.....
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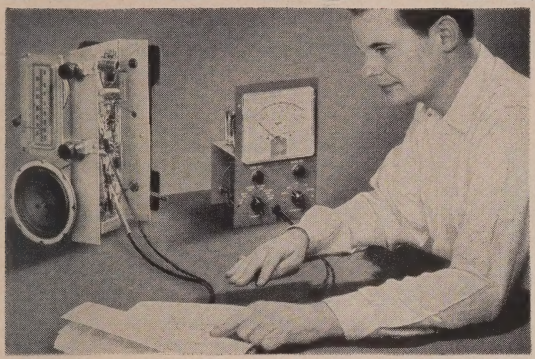

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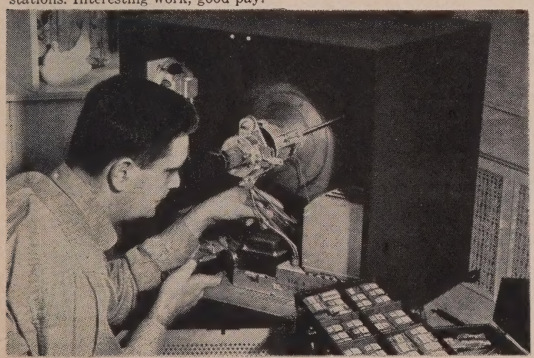

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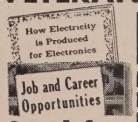
VETERANS—Approved under GI Bills



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ON THE COVER

(Story on page 26)

New stereo equipment in action, with the Electro-Voice ceramic stereo cartridge playing and (below) in exploded form (see box on page 27).

Color original by Habershaw; turntable courtesy H. H. Scott Inc.; arm by Rek-O-Kut; Audio Fidelity record.

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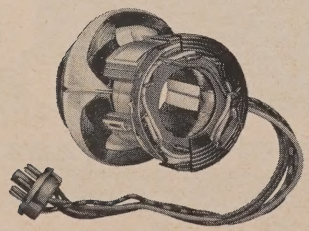

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News Briefs

MONAURAL NOW, STEREO LATER is the plan being advanced by one phono cartridge maker. Shure Brothers, Inc., has introduced its new monaural Dynetic cartridge with the guarantee that each person who buys one now can, if he wishes, exchange it next fall or spring for a stereo model and receive credit for 75% of the original purchase price ($27.50) of the monaural unit. The stereo cartridge will sell for $45, or $24.37 if a monaural cartridge is traded in. A similar deal is being offered in connection with the company's Dynetic tone arms.

MORE RADIO STATIONS would be squeezed into the broadcast band under an FCC proposal which would permit new stations to operate on some of the hitherto sacrosanct "clear-channel" frequencies. The commission selected 12 of the 24 so-called "class 1-A" clear channels (frequencies preserved for exclusive use of a single station) and proposed that other stations be allowed to operate on them, protecting the dominant station by using directional antennas or lower power at night.

The FCC also proposed to let one additional full-time 50-kw outlet operate on each of 5 of the 12 frequencies selected. Stations occupying the 12 clear channels which would be affected are all located in the Eastern US. The added stations would be in the West or Southwest. An increase in the current 50-kw power ceiling for at least some clear-channel stations is also favored, the FCC indicated. Clear-channel broadcasters have asked for a ceiling as high as 750 kw.

The commission has been deliberating on various suggested changes in the clear-channel setup for more than 12 years and its proposal is its first specific step toward altering the status of clear-channel stations. It is unlikely that the commission will take any final action in this case before the end of 1958—and, of course, the proposal may be altered considerably after the comments of interested parties have been filed.

NEARLY 70,000,000 TV SETS are in use throughout the world, on the basis of an estimate of overseas television receivers released by the US Information Agency.

At the end of this year's first quarter, USIA reported, there were 18,478,000 sets in use in foreign countries, excluding Canada. There are an estimated 47,500,000 sets in the US and about 3,000,000 in Canada. The USIA said the first quarter of 1958 saw the biggest growth to date in foreign television, the Free World adding 1,500,000 receivers

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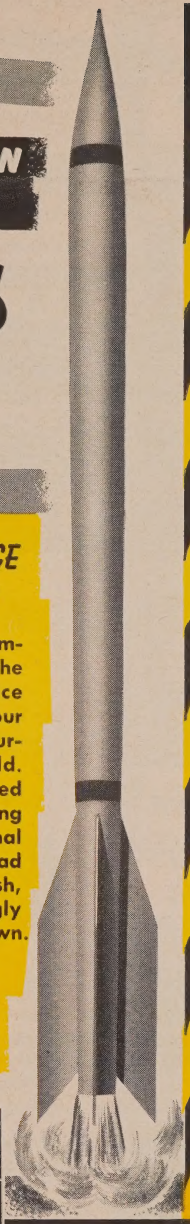

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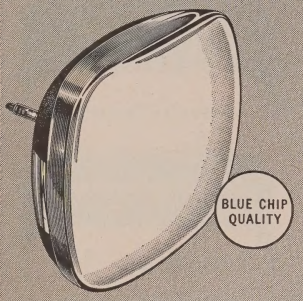

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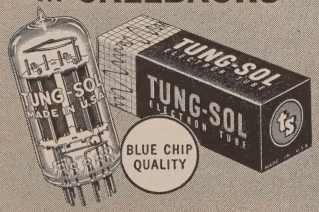

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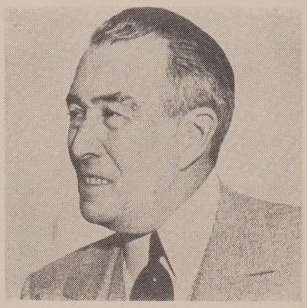
and Communist bloc nations 600,000. During the same period, 57 new TV transmitters went on the air in overseas countries, 46 in the Free World and 11 in Communist countries.

Japan became the fourth overseas country to pass the 1,000,000-set mark, others being United Kingdom with 8,500,000, USSR 2,500,000 and West Germany 1,500,000.

TELEVISION FOR EIRE: The Irish Government has taken the first step toward the establishment of television by appointing a Television Commission to hold hearings and make recommendations. While some parts of the country currently can receive TV programs from England, the Irish Government has made it clear that the future television system should "provide for the use of the Irish language and for the adequate reflection of the national outlook and culture."

COMMANDER EUGENE F. McDONALD, JR., founder and chairman of Zenith Radio Corp., died May 15, less than a month after he stepped down as president of the Chicago company.

His activities in radio began in 1921 as the Chicago Radio Laboratory, becoming Zenith in 1923. Also in 1923 he founded Chicago radio station WJAZ and organized the National Association



of Broadcasters, becoming its first president. He and his product began making headlines shortly thereafter when he became second in command on Admiral Donald B. MacMillan's Arctic expedition and succeeded in communicating by shortwave with a Navy vessel 12,000 miles distant. This incident was credited with convincing the Navy of the value of long-distance shortwave radio communications.

Partially deaf, he became known as a benefactor of the nation's hard of hearing in 1943 when he introduced an electronic hearing aid at far below the prevailing prices. Among large radio manufacturers he was regarded as a maverick, backing such "unpopular" causes as FM, noncommercial radio and television and pay TV.

ATOMIC TESTS AND MISSILE FIRINGS halfway around the world may be detected by a new method now under development by the Government, according to the magazine *Aviation Week*. The long-range detection method utilizes electromagnetic signals between 10 and 20 kc, generated by the blasts. At these low frequencies, the earth and ionosphere serve as parallel plates, resulting in high reliability and very little loss of signal.

Missile or nuclear blasts can be pinpointed through the use of three or more widely separated receiving stations, with calculations based on time difference in the arrival of the signals at the various stations. As a substitute for radar it has the advantage of vastly greater range (not being limited to line-of-sight) and presumably is less vulnerable to enemy interference.

ONE NEW TV STATION has gone on the air:

KNME-TV, Albuquerque, N. M..... 5

The count remains the same, however, because we have also lost a station:

KGEZ-TV, Kalispell, Mont..... 9

Consequently, the total of US operating stations is still 541 (446 vhf and 95 uhf) with 31 noncommercial.

Canada has boosted its station tally to 51 with the addition of:

CJES-TV-1, Estcourt, Que.....70
CKTM-TV, Trois Rivieres, Que.....13

CJES-TV-1 is a satellite of CJBR-TV in Rimouski, Que.

ONE HOME IN EVERY 14 now is equipped with more than one television receiver, the US Census Bureau reported. Its TV set tabulation, based on a nation-wide sample of 35,000 households, also indicated that 83% of US homes had television in January, 1958, or a total of 41,924,000 homes with receivers.

Television sets in homes totaled 45,952,000 in January, according to an estimate by Advertising Research Foundation based on the Census Department's sampling results. The saturation figure of 83% compares with 80.2% in April, 1957, and 67.2% in June, 1955, when Census took its first TV survey.

Multiple-set homes increased to 7% of total US households in January, 1958, or almost 3,500,000, from 5% in April, 1957, and 4% in February, 1956. The Census Bureau survey was financed by the broadcasting industry.

DR. KARL LARK-HOROVITZ, whose early researches on semiconductors helped pave the way for the development of the transistor, died April 14 at the age of 65. Among other fields of research in which Dr. Lark-Horovitz was internationally known were nuclear physics, X-ray crystal structure and glass. He was head of the Purdue University Physics Department.

ELECTRONIC TEACHER is being employed in Britain to train operators of card-punch systems. Its manufacturer says it does the job in one-third the time required by a human teacher. Made by Solartron Electronic Group Ltd., it has been nicknamed Saki (for *S*olartron *A*utomatic *K*eyboard *I*nstructor).

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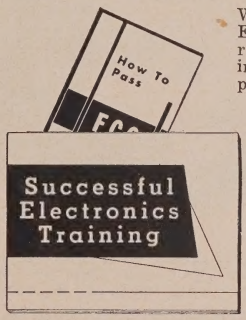

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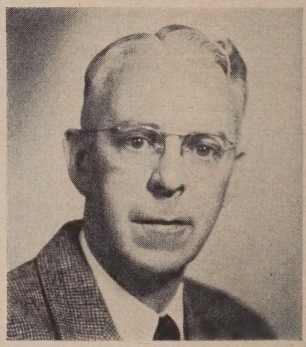
full-time instruction. It resembles a small card punch, but has an additional instruction box with set of lights on its face. The lights instruct a student which keys to press, speeding up as the student's proficiency increases. The machine detects a student's weak spots and concentrates on them. It's being offered for sale at $1,400–$1,600.

DR. HAROLD S. BLACK, inventor of the negative feedback amplifier, whose inventions are credited with having made possible modern multichannel transcontinental and transoceanic communication systems, was awarded the Lamme Gold Medal of the American Institute



of Electrical Engineers June 23 in recognition of "his many outstanding contributions to telecommunications and allied electronic arts, especially the negative feedback amplifier." Dr. Black is a Bell Telephone Laboratories research engineer.

Calendar of Events

Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers, Aug. 6–8, Hotel Statler, Los Angeles, Calif.

Conference on Electronic Standards and Measurements, Aug 13–15, Radio Standards Laboratory, Bureau of Standards, Boulder, Colo.

West Coast Electronic Show and Convention, (WESCON) Aug. 19–21, Ambassador Hotel and Pan Pacific Auditorium, Los Angeles, Calif.

ELECTRONIC SERVICING was a $2.6 billion business in 1957, Electronic Industries Association's servicing committee estimates. Of the total amount, replacement parts including tubes and transistors accounted for $900,000,000 in factory value, the remaining $1.7 billion representing labor and wholesale and retail markups of repair parts.

FIRST ELECTRONIC HIGHWAY system is now in operation at the entrance to RCA's David Sarnoff Research Center, Princeton, N. J. It's a transistorized variation of the automatic electronic vehicle control system developed by an RCA Laboratories research team headed by Dr. Vladimir K. Zworykin. Two wire loops buried in the pavement detect passage and speed of cars. If a car exceeds the speed limit, the circuits automatically illuminate the warning sign at the roadside 20 yards ahead.

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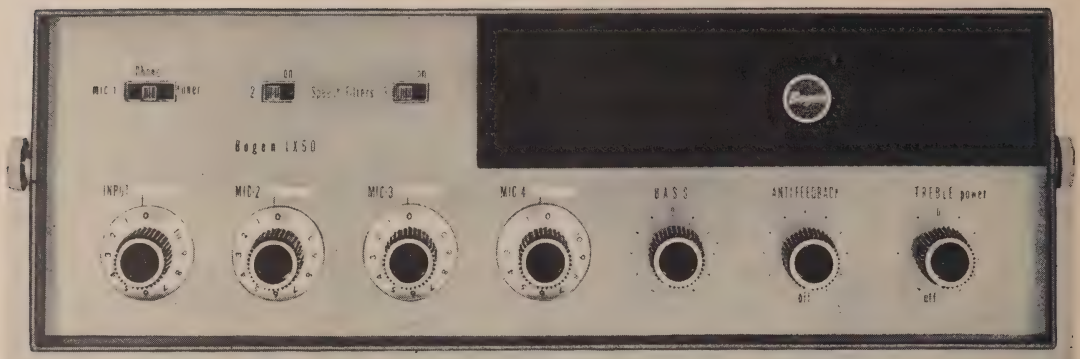

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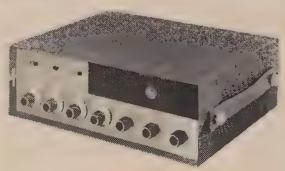

Deluxe LX30 30-Watt Amplifier

4 Microphone Inputs (panel switch converts one microphone channel for phono or tuner); Built-In Remote Gain-Control Circuit; Exclusive Anti-Feedback Control; Speech Filters; Separate Bass and Treble Tone Controls.

H. 5¾", W. 16¼", D. 13". Wgt.: 25 lbs.

Superb L330 30-Watt Amplifier

3 Microphone Inputs (panel switch converts one microphone channel for phono or tuner); Speech Filters; Separate Bass and Treble Tone Controls.

H. 5¾", W. 14¼", D. 13". Wgt.: 24 lbs.

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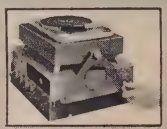

4 thumbscrews attach accessory record player mount.

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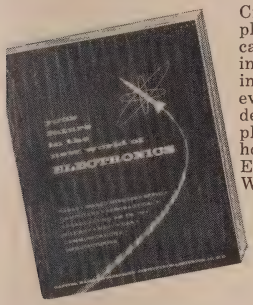

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NEW CONCEPT IN SOUND

Dear Editor:

It has been shown that two radiators of 6-inch diameter will exhibit the same radiation as a single radiator of 12-inch diameter.[1]

To quote: "Although two 6-inch speakers have only one-half the piston area of a 12-inch speaker, they are as efficient when mutually coupled as a single 12-inch speaker of similar characteristics."

Pursuing this step by step to its logical conclusion, a further subdivision by 2 would result in four diaphragms of 3-inch diameter, and so on. Thus if D is the original diameter, 12 inches in the example, this is divided by 2, 4, 8, 16 . . . 2^n and the number of diaphragms multiplied by the same factors 2, 4, 8 . . . 2^n. Since the impedance per unit area is established by Rayleigh[2] and the Bessels functions are available in published reference works[3], it follows that any subdivision of radiation surface may, therefore, be explicitly defined.

The area of each individual diaphragm becomes

$$A_j = (D \times 2^{-n})^2 (\pi/4) = D^2 2^{-2n} (\pi/4). \quad (1)$$

and the number of diaphragms becomes 2^n. The total area of the coupled array is therefore

$$A_c = D^2 2^{-2n} (\pi/4) \times 2^n = D^2 (\pi/4) 2^{-n}. \quad (2)$$

and the original area is $D^2(\pi/4)$. Thus the resultant area is smaller than the original area, the factor of reduction being 2^{-n}. If the value of n is some quantity like 2, the advantage to be gained is not immediately evident. But suppose we make $n = 10$, so that 2^n becomes 1,028 and 2^{-n} is .0097273 (very approximately). This is to say that for the original 12-inch speaker we now have 1,028 minute radiators, each only .00097273 foot (roughly .00117 inch) in diameter.

This formidable array may look like an expensive approach but, again, let us go one step further. The total area of this new array, from equation (2), $n = 10$,

$A_c = 12^2(\pi/4)2^{-10} = .10099$ square inch, or exactly 1/1,028 as much as the original area.

Now still one more step. Since the 1,028 individual small radiators are

[1] Joseph Marshall, *Multiple Speakers*, RADIO-ELECTRONICS, September, 1955, pp. 100–108.
[2] Lord Rayleigh, *Theory of Sound*, Macmillan & Co., London, England, 1898, Vol. 2, pp. 162–69.
[3] Jahnke and Emde, *Funktionentafeln*, Teubner, Leipsig, 1933; Zylinderfunktionen, pp. 126–30 (Ed. 1943 Rev.)

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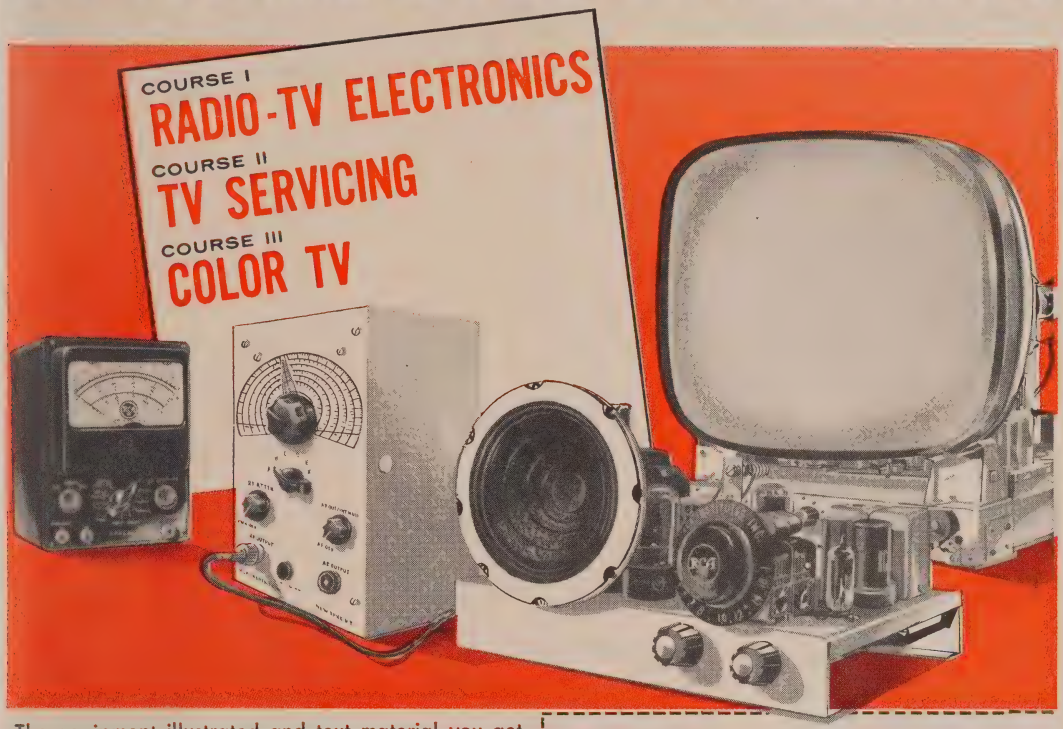

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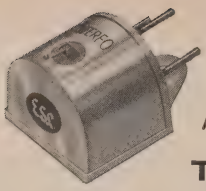

For the stereo perfectionist

The new ESL GYRO/JEWEL

No longer need perfectionists compromise with inferior or makeshift stereo pickups. From the distinguished laboratories which achieved the world-famed ESL Concert Series and C-60 Series cartridges comes a new milestone in audio progress: the ESL GYRO/JEWEL, *the stereo cartridge of tomorrow.*

If you are technically minded, you will be pleased to learn that the triumphant design of the ESL GYRO/JEWEL *is based upon two of ESL's patented, subminiature D'Arsonval movements, coupled to the stylus shoe by ESL's unique new Gyro/jewel.*

You will be pleased, also, to learn that the ESL GYRO/JEWEL *excels in vertical compliance (5×10^{-6} cm/dyne), lateral compliance (5×10^{-6} cm/dyne), dynamic mass (.003 gms), channel separation (20 to 25 db), and frequency response (±3 db from 30 to 15,000 cps, with response extending well beyond 20 kc).*

But only through actual listening can you realize the vast superiority of the ESL GYRO/JEWEL. *Compare it at your audio dealer's, and you'll want to own this stereo cartridge that's years ahead. Only $85; write for details.*

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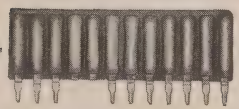

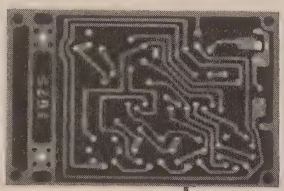

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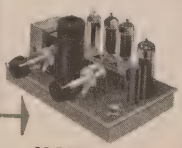
***featuring* "PAC" and an ERIE Printed Wiring Board**



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SPECIFICATIONS FOR ERIE STANDARD AUDIO-AMPLIFIER

- *Frequency Response:* 30 cycles to 12,000 cycles +0, —3.5 db.
- *Sensitivity:* 0.56 volt RMS (input at 1 KC) for 2 watt output.
- *Power Output:* 2 watts • *Input Impedance:* 2 megohms.
- *Output Impedance:* 4 ohms • *AC Power Consumption:* 17 watts.
- *Overall Dimensions:* 6⅝" L x 4⅝" W x 3⅞" H • *Shipping Weight:* 2 lbs.

See and hear it at your local distributor or *Write* for nearest source.

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coupled, by the original postulate, they may be combined into a single radiating surface and driven by a single voice coil. Whence it follows *Quod Error Demonstrandum* that the original function of the 12-inch cone speaker may be accomplished by the much smaller (.1099-square-inch) area provided by a 0.3315-square-inch cone or a round one 0.4225 inch in diameter. Note the further reduction in size afforded by the square cone or *pyramidoidic frustratum superfacium.*

Obviously the value of n may be made any convenient value; slide rules may be made any length. If n is made large without limit, 2^{-n} becomes vanishingly small; on reaching infinitesimal values it may be ignored altogether, and the speaker omitted entirely. Erstwhile advocates of large and expensive speakers in sound reproduction systems are thus relegated to an era that is already past.

Laboratory corroboration of the basic theory was enlightening. For the experiment n was taken as 6, and 32 radiators of .03125-foot diameter were driven by .015625-inch diameter voice coils removed from as many shortvalve VI model stereococci pickout heads at the retail price of $250 each. Recognition *a posteriori* of the economy of the common voice coil did not relieve the *a priori* expense.

The pressure-response curve divided by n corresponded within irrational standard deviations with the frequencies. Expressed in decibels, the factor of correlation was n where n is the same n used in equations (1) and (2). Obviously with an increase in values of n, the reduction may be extended to the point where the pressure-response curve may be eliminated completely, and total reliance can be placed hereafter on published data.

D. C. BELZ
Hope, Ark.

"INDEPENDENT" TECHNICIANS

Dear Editor:

I was pleased to see that Howard L. Nowry of Clearwater, Fla., was interested enough in my article "Minimum or Maximum Job" (RADIO-ELECTRONICS, December, 1957, page 98), to write in a letter ("Just Fix It," May, 1958). Mr. Nowry is very fortunate to be located on the west coast of Florida. Early this year I was passing through this area and the generator on my car died. I dropped the car off at the local car agency and went for a walk while it was being repaired.

Naturally I ended up in a couple of the local TV service shops. Here is the TV situation in that area as I could see it: There are fewer TV technicians per TV sets than I've ever seen. Competition is nil. One shop owner offered me a handsome salary to start if I would stay and handle his always bulging bench work. His calls were all routed for 48 hours ahead.

Mr. Nowry is located in a really lush

(*Continued on Page* 20)

What Does F.C.C. Mean To You?

What is the F. C. C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress in 1934 to regulate all radio communication and radio and television broadcasting in the United States.

What is an F. C. C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses—commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams"—people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F.C.C. Elements I and II covering radio laws, F.C.C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain, and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain, and operate every type of radiotelephone equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelephone license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the *Grantham Correspondence Course*, the average beginner with NO previous experience or training in radioelectronics should obtain his *second class* radiotelephone license after from 200 to 300 hours of study. This same student should then prepare for his *first class* FCC license in approximately 100 additional hours of study.

In the *Grantham Resident Course*, the time required to complete the course and get your license (under normal circumstances) is as follows:

In the DAY course (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class*.

In the EVENING course (2 nights a week) you should get your *second class* license at the end of the 22nd week of classes and your *first class* license at the end of 8 additional weeks of classes. This makes a total of approximately 7 months required to cover the whole course, from "scratch" through *first class*, in the evening course.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and pre-examination you are given constant practice in answering FCC-type questions, presented in the same manner as the questions you will have to answer on your FCC examinations.

Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand—choose Grantham School of Electronics.

Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

HERE'S PROOF that Grantham Students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Wks.
Albert Meehleib, Box 136, Elrama, Pa.	1st	12
Leo Bishop, 37 Calle Contenta, Flagstaff, Ariz.	1st	12
Carl Deare, Jr., P.O. Box 467, Jeanerette, La.	1st	11
Robert Umthun, 1918 Eye St., NW, Washington, D.C.	1st	21
Dan Breece, Station KOVE, Lander, Wyo.	1st	12
Robert Todd, Station WWBG, Bowling Green, Ohio	1st	13
Jackson York, 1029 N. Quincy St., Arlington, Va.	1st	15
Paul Chuckray, 6874 Weber Rd., Affton, Mo.	1st	11

OUR GUARANTEE: If you should fail the F.C.C. exam after finishing our course, we guarantee to give you additional training at NO ADDITIONAL COST. Read details in our free booklet.

TWO COMPLETE SCHOOLS

To better serve our many students throughout the entire country, Grantham School of Electronics maintains two complete schools—one in Hollywood, California and one in Washington, D.C. Both schools offer the same rapid courses in F.C.C. license preparation, either home study or resident class.

For further details concerning F.C.C. licenses and our training, send for our FREE booklet, "Opportunities in Electronics". Clip the coupon below and mail it to the School nearest you.

Get your First Class Commercial F.C.C. License in 12 weeks by training at

GRANTHAM SCHOOL OF ELECTRONICS

HOLLYWOOD DIVISION

1505 N. Western Avenue, Hollywood 27, Calif. Phone: HO 2-1411

WASHINGTON DIVISION

821 - 19th Street, N.W., Washington 6, D.C. Phone: ST 3-3614

MAIL TO SCHOOL NEAREST YOU

Grantham Schools, Desk 84-K

821 - 19th Street N.W. Washington 6, D.C. **OR** 1505 N. Western Ave. Hollywood 27, Calif.

Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

Name _____ Age _____

Address _____

City _____ State _____

I am interested in: ☐ Home Study, ☐ Resident Classes

At Raytheon, we test tubes to find out how *good* they are, not how bad. Accepted methods of testing tubes like the 1B3GT often resulted in subpar tubes. To improve and maintain the quality of Raytheon 1B3GT Tubes, Raytheon developed an expensive but super-accurate method of life testing these tubes.

Tests on the improved Raytheon 1B3GT far exceeded our expectations. Receiver life tests of the Raytheon 1B3GT showed not a single failure at 600 hours. (No worries about early life tube failure here.) At 1850 hours a sensational 93% of these tubes were still operating at rated efficiency in spite of the fact that *these sets were operated at 10% above their rated line input and cycled on and off every two hours.*

These torturous Raytheon Tube tests not only prove the quality of Raytheon Tubes, they help maintain that quality. Tubes are constantly checked and tested and any variance in quality is instantly noted and quickly corrected.

That's why you can use Raytheon TV and Radio Tubes with complete confidence in their quality — with full knowledge that you are giving your customers tubes that are RIGHT . . . for Sound and Sight.

New Raytheon 1G3GT, 1J3GT and 1K3GT Tubes are also subjected to the Raytheon Fly-Back Tests — and as a result meet Raytheon's highest standards of quality. Ask your Raytheon Tube Distributor for them.

RAYTHEON MANUFACTURING COMPANY

Receiving Tube and Semiconductor Operations

NEWTON 58, MASS. 55 Chapel Street
CHICAGO, ILL. 9501 Grand Ave. (Franklin Park)
ATLANTA 6, GA. 1202 Zonolite Rd., N.E.
LOS ANGELES 7, CALIF. 2419 So. Grand Ave.

Raytheon makes all these { Receiving and Picture Tubes, Reliable Subminiature and Miniature Tubes, Semiconductor Diodes and Transistors, Nucleonic Tubes, Microwave Tubes.

RAYTHEON

Excellence in Electronics

Up goes another Winegard!

More Winegard Colorceptors are being sold today than any other all-channel yagi.

Discover for yourself the profit and personal satisfaction that come from selling the very finest antenna that can be installed on your customer's home.

See your distributor for free Winegard sales aids and displays.
Write for Technical bulletin WCL4.

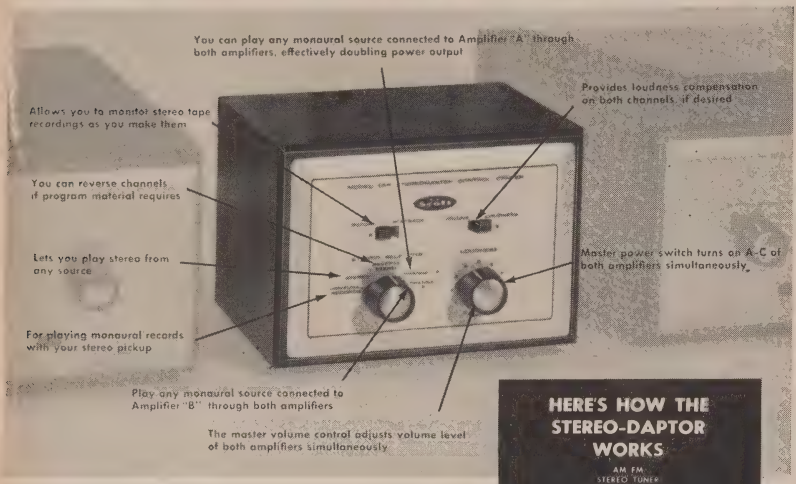
Winegard Co.

3013-7 Scotten Blvd., Burlington, Iowa

Shown is Model CL-4

Photo by R. K. Sunderbruch

HERE IS HOW YOU CAN CONVERT TO STEREO...


You can play any monaural source connected to Amplifier "A" through both amplifiers, effectively doubling power output
Allows you to monitor stereo tape recordings as you make them
Provides loudness compensation on both channels, if desired
You can reverse channels if program material requires
Lets you play stereo from any source
Master power switch turns on A-C of both amplifiers simultaneously
For playing monaural records with your stereo pickup
Play any monaural source connected to Amplifier "B" through both amplifiers
The master volume control adjusts volume level of both amplifiers simultaneously

NEW H. H. SCOTT STEREO-DAPTOR

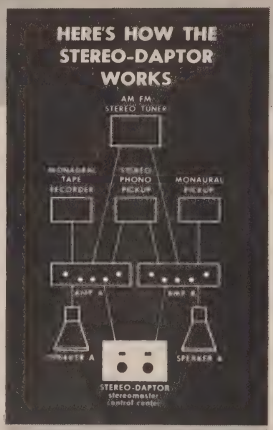
- Updates your *present* H. H. Scott System for Stereo records and tape.
- Lets you buy a monaural H. H. Scott System *now;* convert later.

Just add the Stereo-Daptor and a new H. H. Scott amplifier to your present H. H. Scott system and you can play the new stereo records, stereo tape, stereo AM-FM or stereo from any source.

The Stereo-Daptor permits control of two separate amplifiers from a central point. A Master Volume Control adjusts the volume levels of both channels simultaneously. Special switching lets you play Stereo, Reverse Stereo, use your Stereo Pickup on Monaural Records, or play monaural program material through both amplifiers at the same time. This gives you the full power of both amplifiers. No internal changes are required when used with H. H. Scott amplifiers.

only $24.95*

IMPORTANT! Stereo-Daptor works with *All* current H. H. Scott amplifiers and most older models . . . with any system having separate pre-amplifier and power amplifier . . . and with complete amplifiers having tape monitor input and output provisions.



SPECIFICATIONS

H. H. Scott Stereo-Daptor
Stereomaster Control Center

Compatibility: Any amplifier in any of the groups shown below may be used with a second amplifier IN THE SAME GROUP for best results with the Stereo-Daptor.
Group I: 99-A,B,C,D; 210-F; 120-A; 120-B; 210-C.
Group II: 121-A,B,C; 210-D,E.
Group III: Any systems with separate preamplifiers and power amplifiers.
Group IV: Two identical complete amplifiers having tape monitoring input and output connections.

Controls: Master Volume; Loudness-Volume; Function Selector (with these positions — Stereo; Reverse Stereo; Monaural Records; Monaural Channel A; Monaural Channel B) Tape Monitor; Power off (on volume control).

Connecting Cables: Four two-foot shielded cables are supplied for all necessary connections. Maximum recommended cable length 3 feet.

Custom Installation: The Stereo-Daptor is easily custom mounted, and no special mounting escutcheons are required.

Price: $24.95* completely enclosed. Accessory cases extra

*slightly higher West of the Rockies

Send for Complete Information Now

H. H. Scott Inc. 111 Powdermill Road, Maynard, Mass.
Export: Telesco International Corp., 36 West 40th Street, New York City

Rush me complete information on the New H. H. Scott Stereo-Daptor and your new catalog RE-7.

NAME.....

ADDRESS.....

CITY.....STATE.....

TV service territory. That's probably why he can keep his "independent" attitude and still remain in business. I wonder how he would fare in the New York area, which is highly competitive.

After seeing the Florida west coast TV picture I am sorely tempted to move in there myself. Unfortunately my commitments up North won't allow me to do so.

ART MARGOLIS

Levittown, Pa.

WORTH PAYING FOR

Dear Editor:

In your May issue you published a letter from M. Ciketic of Los Angeles opposing pay TV ("Let's Stop Pay TV"), in which he tells us to stop pay TV at once. I think Mr. Ciketic does not understand the procedure of pay TV.

I've been a TV service technician for the last 6 years, and I don't think pay TV will interfere with free TV as we now have it. I'm in favor of pay TV because, in addition to what we now have, we would add other types of entertainment, such as opera, symphony concerts, championship boxing and first-run movies. No sponsor will put those on the air. So if I'm willing to pay for my programs I don't see why people like Mr. Ciketic want to control my money.

If you want to do justice to pay TV, you should tell the true story. I myself want pay TV and I'm willing to pay for it. Free programs will remain as they are. The truth is what is important in this matter.

I have been a subscriber to RADIO-ELECTRONICS for the past 5 years. Good luck to you.

SALVATOR TIBERI

Chicago, Ill.

GIVE PAY TV A TRY

Dear Editor:

The assumption that many people make is that pay TV will deprive them of free TV. This is not so, if only for the reason that the public would not accept it.

When toll highways were first proposed, a similar situation developed where a few folks circulated petitions and wrote their congressmen, etc., but what emerged was a supplemental road system which is greatly appreciated by those who wish to use it and in no way harms those who don't.

Pay TV, to be acceptable to the people, must provide a supplemental service they want at a price they are willing to pay. The proponents of pay TV should be given the chance to develop an acceptable service and not to be stifled by legislation. People tout our "democratic way of life" and in the same breath propose to legislate it away!

JAMES B. WRIGHT

President, Pittsfield Community Antenna, Inc.
Pittsfield, Mass.

END

WE'RE MAKING IT EASIER THAN EVER TO BECOME A WELL PAID

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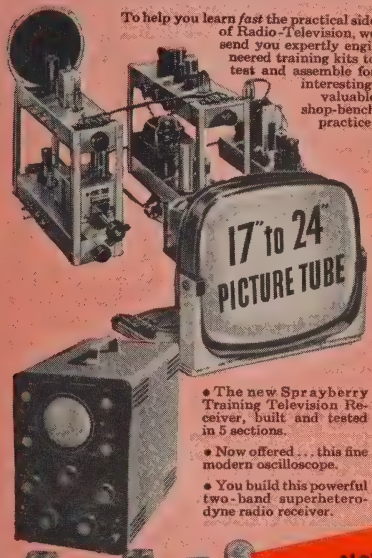
NOW — Just $6 Starts You Training in RADIO-TELEVISION

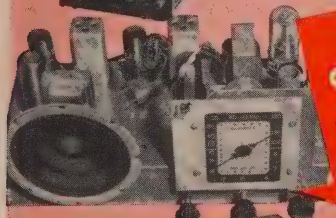
the SPRAYBERRY "Learn-by-Doing" Way . . .

25 BIG, COMPLETE KITS of PARTS & EQUIPMENT

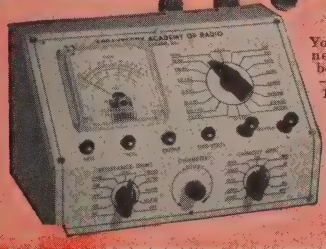
To help you learn *fast* the practical side of Radio-Television, we send you expertly engineered training kits to test and assemble for interesting, valuable shop-bench practice!



- The new Sprayberry Training Television Receiver, built and tested in 5 sections.
- Now offered . . . this fine modern oscilloscope.
- You build this powerful two-band superheterodyne radio receiver.



Big New CATALOG AND Sample Lesson FREE!



You build the new Sprayberry tester—a complete 18-range Volt-Ohm-Milliammeter test meter.

★ ★ ★ ★ This great industry is begging for trained men . . . to step into good paying jobs or a profitable business of their own! Our new plan opens the doors of Radio-Television wide to every ambitious man who is ready to act at once!

Men by the thousands... trained Radio-Television Service Technicians...are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—*just $6 enrolls you* for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need...to step into a fine job or your own Radio-Television Service Business.

Complete Facts Free—Act Now; Offer Limited

Only a limited number of students may be accepted on this liberal and unusual basis. We urge you to act at once...mail the coupon below and get complete details plus our big new catalog and an actual sample lesson—*all free.* No obligation...no salesman will bother you.

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Under world-famous 27-year old Sprayberry Plan, you learn entirely at home in spare time. You keep on with your present job and income. You train as fast or as slowly as you wish. You get valuable kits of parts and equipment for priceless shop-bench practice. And everything you receive, lessons and equipment alike, is all yours to keep.

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Please rush all information on your ALL-NEW Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me. Include New Catalog and Sample Lesson FREE.

NAME..... Age.....

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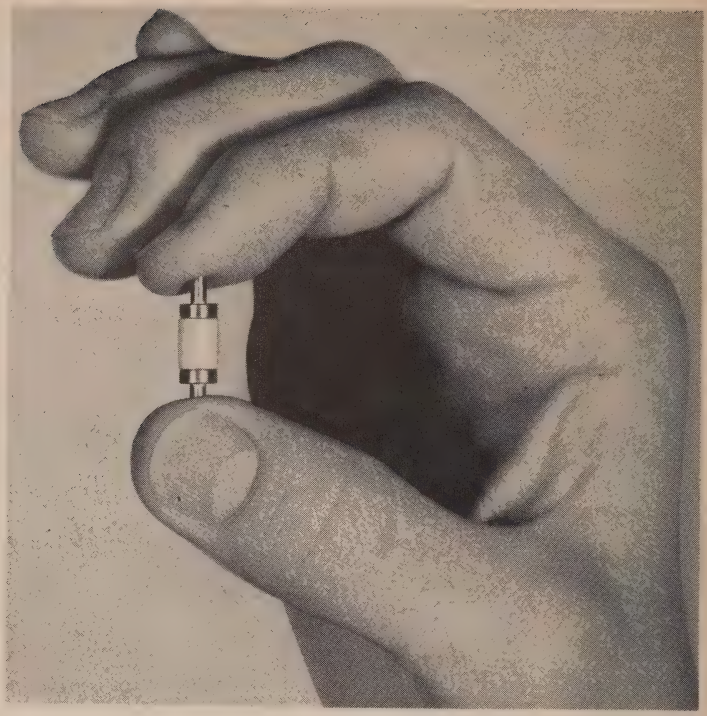
NEW DIODE SPEEDS VOICES— AT 6,000,000,000 C. P. S.



How the radio art can be improved through solid state science is illustrated by a recent development at Bell Telephone Laboratories. To make voice signals travel by microwaves they must first be "converted"—caused to vibrate at billions of cycles per second. To date, it has been possible to accomplish this conversion only at the cost of appreciable loss of signal energy. Could a more efficient converter be provided?

In the field of solid state science it was known—as a laboratory curiosity—that semiconductor diodes can be made not only to convert the frequency of signals, but also to amplify them. At Bell Laboratories Dr. Arthur Uhlir, Jr., and his associates calculated that this amplifying action could be put to practical use. They proved the point by developing a junction diode converter which can deliver up to 40 times as much signal energy as previous converters.

This efficient new converter will be applied in a new Bell System microwave highway able to transmit thousands of telephone conversations and a dozen television programs simultaneously at six billion cycles per second. In other forms it is being developed, under Signal Corps contract, for radar and military communications where more efficient frequency conversion can also be used to advantage.

This development is an example of the many different ways in which Bell Laboratories works to improve your telephone service and communications at large.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

the experts say... in High Fidelity the best buys are EICO®

EICO KITS and WIRED

BETTER ENGINEERING Since 1945 EICO has pioneered the concept of test instruments in easy-to-build kit form — has become world-famous for laboratory-precision instruments at low cost. Now EICO is applying its vast experience to the creative engineering of *high fidelity*. Result: high praise from such authorities as Canby of AUDIO, Marshall of AUDIOCRAFT, Holt of HIGH FIDELITY, Fantel of POPULAR ELECTRONICS, Stocklin of RADIO TV NEWS, etc. — as well as from the critical professional engineers in the field.†

SAVE 50% Mass purchasing, and a price policy deliberately aimed to encourage mass sales, make this possible.

EASY INSTRUCTIONS You need no previous technical or assembly experience to build any EICO kit — the instructions are simple, step-by-step, "beginner-tested."

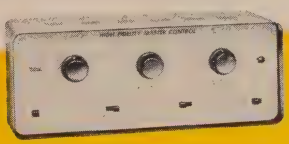
DOUBLE 5-WAY GUARANTEE Both EICO, and your neighborhood distributor, guarantee the parts, instructions, performance . . . as well as *lifetime* service and calibration at nominal cost . . . for any EICO kit or wired unit.

BEFORE YOU BUY, COMPARE At any of 1200 neighborhood EICO distributors coast to coast, you may examine and listen to any EICO component. Compare *critically* with equipment several times the EICO cost — then *you* judge. You'll see why the experts recommend EICO, kit or wired, as best buy.

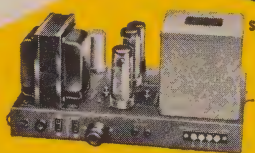
† Thousands of unsolicited testimonials on file.

HFS2 Speaker System

HFT90 FM Tuner with "eye-tronic" tuning



HF81 Preamplifier



HF60, HF50 Power Amplifiers

HFS2 Speaker System: Uniform loading & **natural** bass 30-200 cps achieved via **slot-loaded** split conical bass horn of 12-ft path. Middles & lower highs from front side of 8½" cone, edge-damped & stiffened for smooth uncolored response. Suspensionless, distortionless spike-shaped super-tweeter radiates **omni-directionally.** Flat 45-20,000 cps, useful to 30 cps. 16 ohms. HWD: 36", 15¼", 11½". ". . . rates as excellent . . . unusually musical . . . **really** non-directional" — Canby, AUDIO. "Very impressive" — Marshall (AUDIOCRAFT). **Walnut or Mahogany, $139.95. Blonde, $144.95.**

HFT90 FM Tuner equals or surpasses wired tuners up to 3X its cost. New, pre-wired, pre-aligned, temperature-compensated "front end" — drift-free. Sensitivity, 1.5 uv for 20 db quieting, is 6X that of other kit tuners. DM-70 traveling tuning eye. Response 20-20,000 cps±1 db. Cathode follower & multiplex outputs. **Kit $39.95*. Wired $65.95*. Cover $3.95. *Less cover, excise tax incl.**

HF61A Preamplifier, providing the most complete control & switching facilities, and the finest design, offered in a kit preamplifier, " . . . rivals the most expensive preamps . . . is an example of high engineering skill which achieves fine performance with simple means and low cost." — Joseph Marshall, AUDIOCRAFT. **HF61A Kit $24.95, Wired $37.95, HF61 (with Power Supply) Kit $29.95. Wired $44.95.**

HF60 60-Watt Ultra Linear Power Amplifier, with Acro TO-330 Output Transformer, provides wide bandwidth, virtually absolute stability and flawless transient response. " . . . is one of the best-performing amplifiers extant; it is obviously an excellent buy." —AUDIOCRAFT Kit Report. **Kit $72.95. Wired $99.95. Matching Cover E-2 $4.50.**

HF50 50-Watt Ultra-Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer. Identical in every other respect to HF60 and same specifications up to 50 watts. **Kit $57.95. Wired $87.95. Matching Cover E-2 $4.50.**

HF30 30-Watt Power Amplifier employs 4-EL84 high power sensitivity output tubes in push-pull parallel, permits Williamson circuit with large feedback & high stability. 2-EZ81 full-wave rectifiers for highly reliable power supply. Unmatched value in medium-power professional amplifiers. **Kit $39.95. Wired $62.95. Matching Cover E-4 $3.95.**

HF-32 30-Watt Integrated Amplifier Kit $57.95. Wired $89.95.

HF52 50-Watt Integrated Amplifier with complete "front end" facilities and Chicago Standard Output Transformer. Ultra-Linear power amplifier essentially identical to HF50. The least expensive means to the highest audio quality resulting from distortion-free high power, virtually absolute stability, flawless transient response and "front end" versatility. **Kit $69.95. Wired $109.95. Matching Cover E-1 $4.50.**

HF20 20-Watt Integrated Amplifier, complete with finest preamp-control facilities, excellent output transformer that handles 34 watts peak power, plus a full Ultra-Linear Williamson power amplifier circuit. Highly praised by purchasers, it is established as the outstanding value in amplifiers of this class. **Kit $49.95. Wired $79.95. Matching Cover E-1 $4.50.**

Prices 5% higher in the West

HF12 12-Watt Integrated Amplifier, absolutely free of "gimmicks", provides complete "front end" facilities & true fidelity performance of such excellence that we can recommend it for **any** medium-power high fidelity application. Two HF12's are excellent for stereo, each connecting directly to a tape head with no other electronic equipment required. **Kit $34.95. Wired $57.95.**

HFS1 Two-Way Speaker System, complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps ± 6 db. Capacity 25 w. Impedance 8 ohms. HWD: 11" x 23" x 9". Wiring time 15 min. **Price $39.95.**

THE HI-FI EXPERTS SAY:

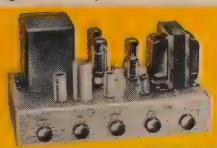
"For those who have been looking for a well-engineered yet inexpensive power amplifier, the newly-released EICO Model HF20 unit might offer a simple solution to their problem. Not only does this unit provide 20 watts of power but the circuit incorporates a preamplifier and a variety of controls on a single chassis."

William A. Stocklin, Editor, RADIO TV NEWS

"The new EICO 'standard' speaker system . . . produces sound that to my musical ears rates as excellent, from high top to clean low bottom."

Edward Tatnall Canby, AUDIO Magazine

Fill out coupon on other side for FREE CATALOG



HF52, HF20 Integrated Amplifiers

HF12 Integrated Amplifier

HF30 Power Amplifier

HFS1 Speaker System

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Over 1 Million EICO instruments in use the world over.

the specs prove it . . your BEST BUY is

EICO®

for COLOR & Monochrome TV servicing

FREE CATALOG

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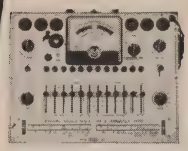

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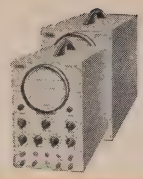

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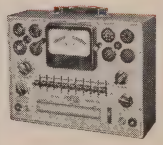

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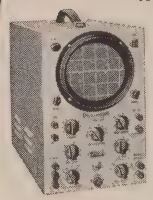

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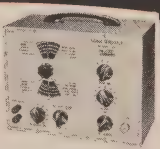

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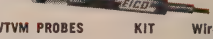

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SERVICE TECHNICIAN AND CLIENT

. . . *Servicing Today Is Becoming Increasingly Complex* . . .

EVER since the beginning of radio servicing in the middle '20's, the technician–customer relationship has been a difficult one, to say the least. The problem is quite complex. On the one side, the lay public does not understand the technicalities involved and usually views any service transaction with suspicion. The technician's dilemma is that he finds it practically impossible to explain his side to the customer. The problem, too, is vastly aggravated by that small minority of dishonest technicians who get wide publicity in the newspapers, while, on the other hand, the hardworking, honest technician hardly ever is mentioned.

Let us stress at once that the situation which prevails with radio and television technicians and the public is not in any way different from other service trades such as plumbing, air conditioning, and refrigerators, dishwashers and other house appliance repair.

As a matter of fact, other trades *charge much more in comparison* for servicing home appliances and, while there is grumbling by customers here, too, it never seems as severe as it does against the electronic technician. The reason: the customer can readily understand what his plumber is doing, but seldom can he fathom what the TV technician has done to put his set into condition. In many instances, when something goes wrong with a television set, the service technician can repair it without the replacement of parts. Hence the customer thinks he is being robbed when he has to pay a service charge. Usually the repair of home appliances means visible parts—the customer can see something for his money. But it is usually the time charge, when only minor repairs are made, that incurs the displeasure of the average TV owner.

We often hear the cry that electronic technicians charge higher fees than doctors. It would appear, however, that physicians are far better off than TV technicians. How many technicians, for instance, have country homes compared to physicians?

Customers should realize that the technician, just as the physician, sells his time and time is a limited commodity—he cannot stretch it. Only so many calls can be made each day. Frequently, when the technician is up against a difficult job—such as an intermittent—where the trouble is not immediately apparent, a large amount of time is consumed before it is located. The nontechnical customer immediately becomes suspicious that the service technician is stretching the time simply to extract a higher fee. This is rarely the case, as no technician worth his salt wants to spend more time than is absolutely necessary on any one job. As a matter of fact, it becomes highly irritating to the average technician if he cannot locate the difficulty in fast order.

Another sore point with many customers is the time spent by the technician going to and from his shop, which usually is charged to the customer. After all, the technician has been called to do the work and he cannot be on hand instantaneously. Someone must pay for the elapsed travel time. Nearly all servicing trades today have a fixed charge, whether work is performed or not. In other words, the time consumed coming and going is charged.

Not so long ago, we had a defective faucet on our dishwasher–disposal unit. We made an appointment with a service man for 10 in the morning, but were called out unexpectedly. The service technician could not get on the premises, but we were billed for his time anyway. We paid the charge.

Another point that the public does not often understand too well is that frequently the service technician must choose between the cost of his time and the cost of replacing a part that *at the moment* might not absolutely need replacement. When a technician finds a circuit not operating (particularly sweep circuits) he may replace all the tubes in that section. This is often cheaper to the customer in the long run than removing and replacing them one at a time to find out whether he can get by with one or two. The technician figures that replacing the additional tubes (that presumably are not in new condition at the time) may prevent future trouble when the tubes do cease to function a little later.

Further, the customer should realize that the cost of TV servicing is constantly going up instead of down. This is caused—aside from inflation—by the new shapes and the compactness of sets, which add to the technician's difficulties and increase the service time. The smaller the set becomes, the more difficult it is to service. This situation is aggravated in the new sets by the so-called series-string tubes. Here we have the difficulty that a defective tube may be one of 15 and it becomes a very time-consuming job to find out *which* tube has gone bad.

He should also consider the all-important axiom that as a receiver ages—say it is over 5 years old—it must, as a rule, be serviced more and more! Tubes now go bad more frequently, resistors, capacitors and other components fail! Old age now takes its toll. In such a situation the service technician must be called in more frequently. Curiously, too, he does not cherish working on over-age sets. They are more difficult to service because too many things are apt to go wrong.

In recent years the earlier rush into the field of the electronic technician has slowed. The reason: it is not one that is lucrative. If the technician has a reputation, is honest and conscientious, he is more likely to undercharge than to overcharge.

A few weeks ago, our television set started to misbehave. The picture was jumping and tearing and we suspected bad tubes. A neighborhood technician was called in and he put in two new tubes. The picture thereupon was steady, and he left. That night when we turned on the set, the sound came on but no picture. We called for the technician again and he found another tube had gone bad *as well as a fuse.* What had happened? Evidently the two new tubes had overloaded one of the circuits when the set was turned on later while all the tubes were still cold. This could happen occasionally and is, at best, an unusual condition. Nevertheless, the technician charged only for the fuse and the tube, but not for his time. This is honest servicing, where the technician takes a loss due to no fault of his own, but it certainly is not lucrative for him.

Service technicians find more and more that they cannot make out in these inflationary days. Many cannot live on radio and television servicing alone. That is why many technicians have diversified their business by handling industrial equipment, diathermy, automatic doors, photoflash equipment and, lately, high-fidelity servicing, which is a special field. In these fields, he finds he can charge more for his time.

A word to the consumer. Be choosy when you employ a service technician. If you use one and find that his work is good, that he is courteous and his charges are reasonable, stick with him. If he is a good man and satisfies you, recommend him. If possible, call in a technician who has been recommended to you by friends.

—*H. G.*

COVER FEATURE

how the STEREO DISC works

The facts on the 45/45 system

By NORMAN H. CROWHURST

A RECENT conversation about the stereo discs ran something like this: "How on earth can a pickup stylus vibrate two ways at the same time and give different inputs for two preamplifiers?"

"That's easy," the answer came. "Every groove has two walls and one recording is cut into each wall of the groove."

The puzzled expression on the questioner's face showed that this did not satisfy him—and for good reason. It is impossible for the stylus to follow different contours on both walls of the groove at the same time. This may have been a simple explanation but it was certainly not the correct one.

In literature issued by Westrex the difference between cutting the two channels appears somewhat as in Fig. 1. It shows a record cutter that has an angle between the cutting faces of precisely 90°. The two drive mechanisms, arranged at 45° to the vertical so the total angle between is 90°, drive this cutter in directions parallel to its faces.

Consequently the diagram may make it seem that the vibrations due to one drive are recorded in one wall of the groove while vibrations due to the other drive are recorded in the other wall.

Stylus and cutter motion

In practice, there is invariably some program in both channels and both vibrations occur at once. So it is more important to consider what happens

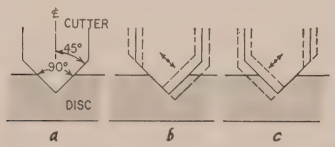


Fig. 1—The basis behind the wrong idea that each channel is cut into one wall of the groove in the 45/45 system: a—no modulation; b—modulation in channel 1 appears to cut only the right wall; c—modulation in channel 2 appears to cut only the left wall.

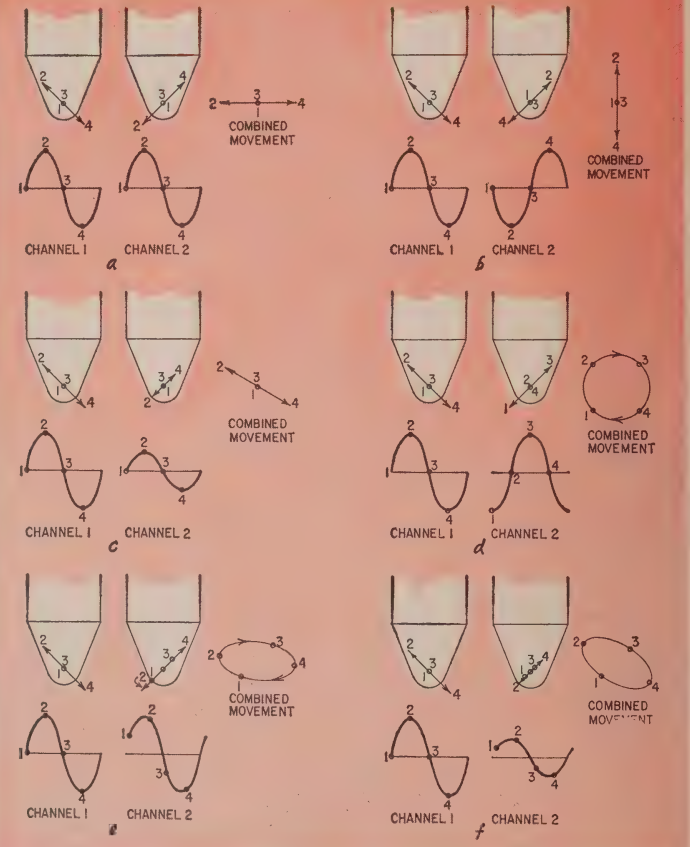
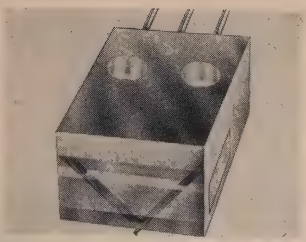


Fig. 2—A more careful analysis of how the cutter, groove and playback stylus move for different intensity and phase relations between channels at any one frequency: a—in phase; b—out of phase; c—intensity difference; d—90° phase difference; e—30° phase difference; f—intensity and phase (30°) difference.



The ESL stereo pickup separates the movement right at the stylus. This is the prototype model.

to the *point* of the cutter than to the contour produced by its two angular cutting edges. This is because the pick-up stylus will (or should) ride in the *bottom* of the groove, cut by the point of the cutter, and it is the movement of this point in the groove that determines the program content of the two channels. To clarify this, let us consider what happens with different program combinations.

If both channels carry the same program at the same intensity and in phase, the movement of the cutter and the pickup stylus will be in the form of a lateral vibration (Fig. 2-a). ("In phase" as explained further down, refers to the system phase, not that of the cutter drive mechanisms.)

But if the inputs are precisely out of phase, the corresponding output from the loudspeakers on playback should also be out of phase, with one loudspeaker pushing when the other pulls. Then the motion of the cutter, groove and pickup stylus will be up and down in a vertical direction (as shown in Fig. 2-b).

If both channels have the same frequency in phase, but the intensity of one channel is stronger than the other, the motion will be predominantly lateral, with a slight angle but less than 45° (as shown in Fig. 2-c).

If both channels carry the same frequency, but the phase relationship is neither in nor out of phase, other movements can occur. At a phase relationship of precisely 90°, the motion of the cutter and the stylus, will be in a circle (Fig. 2-d). Other phase relations with equal intensity will produce an elliptical movement, as shown in Fig. 2-e.

Finally, if there is a difference in both intensity and phase that does not correspond with either an in-phase or out-of-phase condition, the motion of the cutter and ultimately that of the stylus will be in a modified ellipse as shown in Fig. 2-f.

The motions depicted by Fig. 2, of course, represent only what can happen at one frequency at a time. As practical program material contains a variety of frequencies, at various intensities and phase relationships, the cutter, and hence ultimately the stylus, perform an endless variety of patterns, weaving in and out and up and down.

This explains the nature of the groove and what it represents. Now we come to the question of how this information is extracted from the groove by the pickup. But before we proceed, let's clear up the question of phase, because different writings and discussions on the subject use different terms of reference and apparent contradictions arise.

The Electro-Voice cartridge, right, is shown in the insert on the cover with the lower part of the housing (shown as white in this photo) removed and the copper clip normally attached to it floating in air. The two ceramic elements are clearly seen at the base of the red coupling element, running between it and the grayish mounting block at their opposite ends.

Some refer the phase relationship, between the motion in different directions, to the cutter or pickup *mechanism* while others refer it to the overall action of the *system*. The definitions we have used so far, both in the previous article ("Single-Groove Stereo Discs," RADIO-ELECTRONICS, January, 1958) and in this one, are related to *system* phase. This is based on the desirability of the lateral direction of cutter and stylus motion corresponding with the in-phase combination of program in the two channels.

But, related to the simple cutter design shown in Fig. 3, an in-phase movement of the two cutter mechanisms will drive the cutter vertically because the outward thrust of both elements results in a downward movement while the inward pull results in an upward movement.

To reverse the phase relationship to come out with the in-phase input to the two microphones producing a lateral cut, all that is necessary is to reverse the connections to one of the cutter coils. Similarly, if we take careful account of the phasing at the pickup, we can reverse one of the connections between the pickup and the amplifier or at the speaker, so lateral motion of the stylus results in in-phase motion of the loudspeaker diaphragms.

So, if we talk about cutter or pickup phasing, in-phase action produces a vertical cut and out-of-phase a lateral one. But referred to the system—the microphone input or loudspeaker output, it is just the other way around. *To avoid confusion, references to phase in this article are related to the system rather than to the cutter or pickup mechanism.*

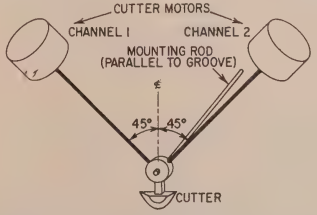
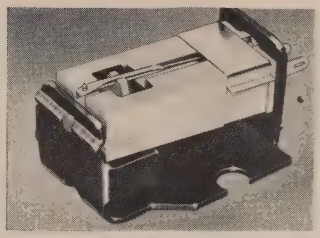


Fig. 3—Basic action of Westrex cutter couples movement in two directions right at the stylus.



The Electro-Voice pickup uses two crystal elements

Now to the pickup

Basically a pickup for stereophonic discs can use the same kinds of transducer elements, for converting the mechanical motion of the stylus into electrical output, as nonstereo pickups. The more common forms are magnetic, moving coil, crystal and ceramic. The way these elements operate follows precisely the same principle as their single-channel forebears. Now we come to the real question, how do we separate the two forms of vibration?

There are two extremes in the way this can be done. One method separates the two movements at the stylus point and couples them by separate mechanisms to individual transducer elements. This is the method used in reverse in the Westrex cutter head. The stylus is carried on a fairly stiff rod, in line with the direction of the groove. The two cutter motors are directly coupled to the stylus point at 45° in two directions, as shown in Fig. 3.

The same method of coupling, applied to a moving-coil pickup, is exemplified in the ESL stereophonic pickup, shown in the photos. It uses two d'Arsonval type moving-coil mechanisms, similar to their well-known single-channel design, both coupled to the same stylus. The stylus is the common point at which the drive separates the two moving-coil transducers.

At the other extreme the stylus motion can be conveyed by a common arm to a pivot or some kind of combination transducer where the two outputs are obtained electrically by separation in the transducer action itself. An example that excellently illustrates this method is the Fairchild stereophonic pickup.

The photos are a magnified view of the central element of the professional model of this pickup. As shown, the bobbins are empty and the actual coils have not been wound. The transparent plastic bobbins can clearly be seen at 45° to the square frame. The thin wires passing through the centers of the side suspend the coil assembly and provide a restoring force to center the coil in its neutral position.

The stylus arm, shown coming down at approximately a 45° angle, can move in almost any direction and pro-

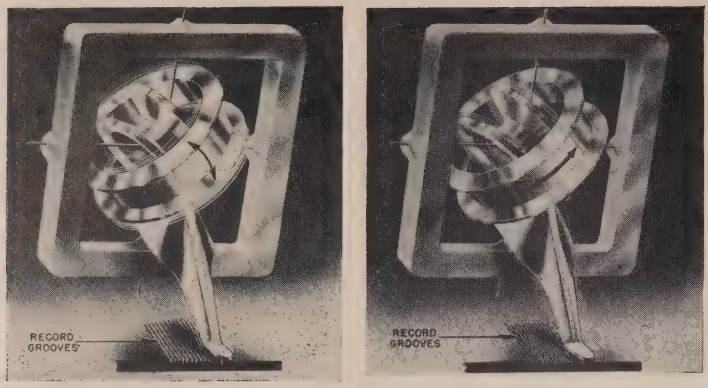


Fig. 4 (a, left, and b, right)—The Fairchild cartridge, a moving-coil type, uses the same stylus arm to transmit the combined vibrations to a double-coil assembly mounted in the same magnetic field.

duce a corresponding combination movement in the coil. The magnetic field that produces the electrical output when the coils move is produced by pole pieces in front and behind the square. The magnetic poles are not shown in the photo because they would obscure the mechanism.

Obviously, if the stylus moves at a 45° angle one way, one coil will be rotating about its own axis and otherwise not moving and will produce no output, while the other coil will be rotating like a d'Arsonval coil between the two pole pieces and produce an electrical output (Fig. 4-a). Motion in the opposite 45° direction will make the first coil produce an output, while the second one rotates about its own axis and does not produce any output (Fig. 4-b).

This construction produces better than 20-db separation between the two motions, over a frequency range extending from the low end up to the region about 10,000 cycles. Above this, separation is not so good, although the response of the pickup is maintained.

These may be regarded as two extremes in method. Practical pickups may well bridge the gap and produce results by methods that would be difficult to list under either one of these extreme headings, perhaps coming close to achieving it by both of them.

Combination pickup

The new Electro-Voice design is one such method. This pickup is shown in the photos and its basic operation illustrated by Fig. 5. Like the Westrex cutter, the stylus is supported by a horizontal rod in line with the direction of the groove. However, a much more flexible rod is used because a stereo pickup requires a high compliance, or flexibility, while the cutter requires quite a reasonable stiffness.

Underneath the clip toward the right of the photograph is a removable mounting for the stylus and rod, so it can readily be changed without replacing the pickup. The stylus arm drives the crystals through a triangular piece of compliant or elastic material. Motion at one 45° angle drives one crystal, while not moving the other one and vice versa.

As a crystal is basically a stiffness or compliant device (the drive force is used to *bend* it rather than *move* it) and these elements in this cartridge are rigidly mounted at their other end, the compliant drive from the stylus arm to the crystal represents a mechanical potentiometer, both elements of which are a compliance or stiffness. This means that if the compliance of the coupling element is five times that of the crystal, then the motion at the tip of the crystal will only be one-fifth of the stylus' motion in that particular direction.

As crystals produce a high output from a microgroove recording, this method still delivers enough output for any high-fidelity preamplifier and it has the advantage, over the more usual method of coupling through a mechanical lever system, that mechanical lever resonances are completely avoided. The dominant mechanical impedance presented to the stylus point is the compliance of the stylus arm itself and its elastic coupling member.

If there is any mechanical resonance in the crystal element within the audio range, it will modify the frequency response but will not produce the damaging effect upon the record usually associated with crystals. Also the use of this "potentiometer" arrangement restricts the magnitude of movement required in the crystal and lets it operate in a range where it is essentially linear. Driving the crystal harder (as the normal lever system does) would run it into nonlinear extremes.

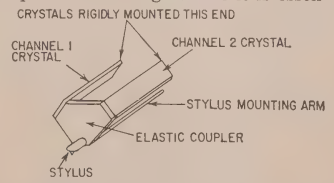


Fig. 5—The Electro-Voice stereophonic pickup uses crystals and transfers the vibrations through an elastic piece that separates them.

With this pickup, separation of channels really takes place in the triangular piece of compliant material. But as this is one piece of material and not two separate links, it seems to "split the difference" between the extremes we started out with. An advantage of this design is the relative purity of the separating method, achieving a high order of discrimination against cross-modulation.

Other variations in the method of splitting the output can be seen by looking at possible ways of doing it in a magnetic construction (see Fig. 6). Here, the slug of magnetic material that produces the variation in magnetic reluctance is attached directly to the stylus arm and varies the reluctance of both magnetic circuits, one for each channel. Motion at one 45° angle will change the gaps in that direction but not in the other direction, and there will be an output from only one coil. Motion in the other 45° angle will produce an output from the other coil. The complicated motion of the stylus following a stereophonic groove produces an output from both coils in the desired stereophonic relationship.

What's the delay?

From this discussion it is evident that there are a variety of ways to make pickups for stereo discs. Also it is evident that there are no serious problems in cutting the discs. A feedback cutter, such as the Westrex, will do a good job of separating the two channels and avoiding cross-talk, provided the two drives are mounted precisely at 90° to each other. So what are we waiting for? Why have not standards been laid down and records already in production, with pickups to play them?

Here we have a "which came first, the chicken or the egg?" type of problem. The pickup manufacturers are looking for test records to determine how good their pickups are, while the record manufacturers need some way to measure precisely what they have cut on a recording. The pickup manufacturers are looking for a perfect or at least adequate test disc or series of test discs, while the recording manufacturers are looking for a perfect pickup or one adequately within range, to determine precisely what they have on their recording.

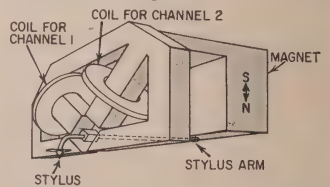


Fig. 6—Another possibility is shown in this diagram of a composite two-coil magnetic assembly.

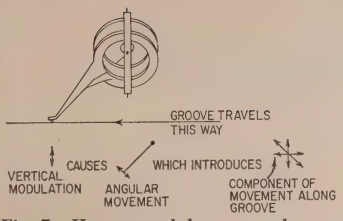


Fig. 7—How an unduly steep stylus-arm angle might cause the vertical component of stylus motion to frequency-modulate the recorded program.

Then there has been the decision about the appropriate groove contour—should the angle be exactly 90° as suggested by Westrex, or would other angles, such as the system proposed by CBS, also be suitable. Also the correct contour for both cutter and stylus has not been selected. Will the contour now standard in the industry for monogroove be used or some other contour? Then we need some way to test for interchannel intermodulation, cross-modulation and other effects that were completely unknown with monogrooves. The official approval of the Westrex system (which is interpreted to include the CBS technique) may hasten action in standardizing these other points.

Perhaps we should point out here that there is a difference at the cutter end between the *drive* being at precisely 90°, or two separate 45° angles, and the *angle of the cutter wedge* being the same. If the stylus really runs along the bottom of the groove, it is not important to have the angle of the groove a precise 45° or 90°. Any angle, so long as it is suitably standardized, will serve the purpose. The important thing is that the stylus must be able to ride the bottom of the groove correctly.

In the design and testing of pickups there are some problems to settle. For example, the Fairchild professional pickup has a stylus-arm angle of about 45° sloping forward (quite apart from the 45° angles of the coils themselves). If the stylus only moves laterally, its motion will be similar to that of any lateral recording. But if the stylus follows a vertical component, even though this may be a partial component due to both the 45° elements, the up-and-down movement of the stylus will also produce a component (approximately equal to it) back and forth along the direction of the groove (see Fig. 7).

This will amount to a Doppler effect along the groove or will result in effective frequency modulation by the vertical component. As the vertical component is not confined to one of the program channels in 45/45, the combined vertical or out-of-phase component of both channels will produce frequency modulation.

We could go on to theorize about this but the real question is, does it really produce distortion? And if it does, is its effect audible as a deterioration of program quality? This is one of many things that still have to be proved. However, it is interesting to note that a new Fairchild pickup has a stylus arm that comes much nearer to being horizontal.

Another thing, this discussion is based on the motion of the stylus remaining simple at all times—we assume it pivots about the cross-bar junction in the center of the coil. But if the vibrations runs into resonant conditions of the cross-wires or stylus arm at any frequency instead of the stylus assembly vibrating as a whole, the investigation becomes even more complex and it is possible that some form of intermodulation or other distortion not yet considered may take place.

Each kind of pickup, and each design approach, will have its own problems. In general, the simplest mechanism is most likely to avoid troubles. But the only real way to determine the effect of these different possible forms of distortion is to measure them—to get test discs with different frequencies recorded on the respective channels, determine possible cross-modulation from one channel to the other, or intermodulation of the audio on one particular channel by other tones on either channel, etc., using discs yet to be made.

Finally, having discovered what degree of intermodulation or cross-modulation exists with any particular pickup or record combination, we still have to determine whether this is important in terms of the end result—listening to the stereophonic program. It must be conceded that all of the pickups recently demonstrated have produced quite listenable stereophonic presentation, even though a rigid theoretical investigation might suggest that some terrible distortion occurs.

From the work done so far and the technological improvement achieved to date, it is evident that stereo discs have a great future. There will be a little shakedown period—getting the bugs out and determining what kinds of distortion really matter or whether they are really present at all—and then it seems we shall have a golden opportunity for getting stereophonic program at a cost no greater than regular LP's. END

4-Track Stereo Tapes Coming

Competition for the stereo disc is on the horizon in the form of a competitively priced prerecorded four-channel tape, completely enclosed in a cartridge. RCA is marketing the tape cartridges as well as a tape player which accommodates them. Professional equipment for making the four-channel recordings is being manufactured by Ampex.

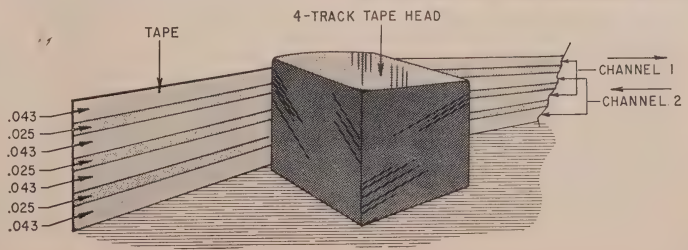
The prerecorded four-channel tapes are designed to provide an hour of stereophonic music at a price equivalent to that of stereo discs. The tape plays at a speed of 3¾ inches per second, has a separation of .025 inch between tracks. One set of two stereo tracks plays in one direction; then by reversing the direction of the tape, the other set is played. Tape width is .043 inch.

One big advantage of the cartridge-loaded tapes, according to the manufacturers, is that they may merely be dropped into the tape player—as easily as playing a phonograph record.

Stereo discs are already off to a strong start, and are on the market at prices from $3.95 to $6.95. Among stereo discs now becoming available across the country are those bearing the labels of RCA Victor, Capitol, Decca, ABC-Paramount, Hallmark, Urania, Esoteric, Contemporary, Electra and Omega. Columbia Records, which had announced its own "compatible" stereo system, changed its mind and joined the rest of the industry in conforming with the 45-45 standard.

Such old-line radio and television manufacturers as Motorola, Zenith, Westinghouse, Admiral and Magnavox have already indicated that they plan to incorporate stereo disc players in future hi-fi models.

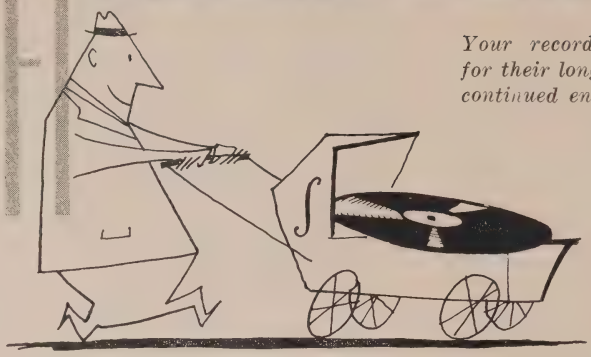
The jukebox makers aren't ignoring the possibilities of stereo. At least one manufacturer is working on a model which can accommodate stereo discs.



(Right) What the prerecorded tape cartridge looks like. (Bottom) How four tracks are placed on ¼-inch tape.

HI-FI RECORD CARE

Your records need babying for their longer life and your continued enjoyment



By ARTHUR A. HUNDLEY*

WITH the advances in sound recording and reproducing techniques of the past few years, a whole new field of opportunity for electronic sales and service has opened up. High fidelity is a definite part of the electronics business and the term "hi fi" is a household word. Improved equipment and know-how have given us the finest facilities for the reproduction of recorded music, but to maintain this superb quality all equipment must be cared for properly. There is one item which can be performed only by the owner—taking care of his records.

The recording companies record music much as it is played in the concert hall, and record players, amplifiers and speakers reproduce this sound with a lifelike brilliance never before known. However, records not properly cared for lose their fidelity, acquire increased noise and cause general dissatisfaction all around. Regardless of how good the equipment is, it will never sound any better than the record itself!

A good record collection represents a sizable monetary investment and it is up to the purchaser to protect it, both to save money and to gain longer-lasting enjoyment. Record care should be a common-sense item, but seeing how some people abuse their recordings leaves no doubt that instruction in basic care is needed.

*DeVry Technical Institute, Chicago, Ill.

Anyone engaged in the hi-fi field—either sales, installation or servicing—can help both himself and the customer by telling him the basic facts of record care. Often this can result in a satisfied customer because then the enjoyment of hi-fi is a long-term process, rather than existing only when new records are played. A more satisfied customer can mean increased profits from the business, so proper record care is of benefit all around.

Most of the newer records are made of vinylite, a plastic, and are unbreakable in normal use. But, however, unbreakable they may be, the grooves which make up the musical portion of the disc can be damaged easily. Each groove is only 1/1,000 inch wide and it doesn't take much of a scratch or abrasion to cut that far into the material, and the disc can be damaged by even smaller cuts.

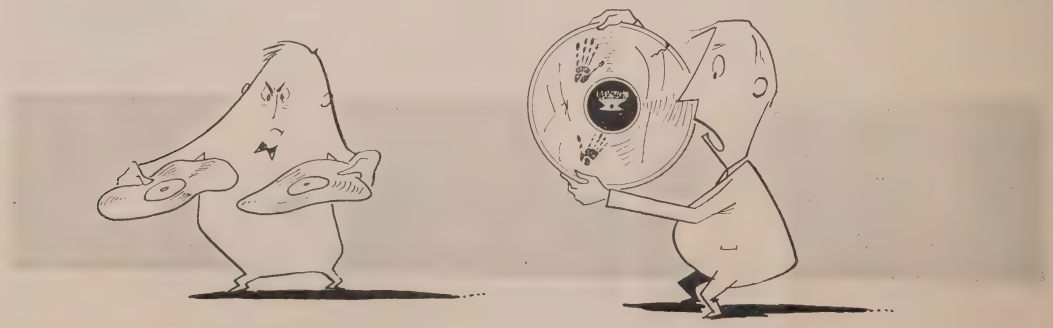
This surface damage causes noise and often distorts the music. The hints given here are aimed at reducing noise and distortion, and increasing the useful life of a record, thus adding to the listener's enjoyment. Properly cared for, discs can be kept noise-free for a long time.

Record containers

Most long playing records are packaged in a cardboard envelope open on only one end, and many of the companies are additionally enclosing the discs in a plastic or paper container which fits inside the cardboard cover. The first rule in record care is always to store each record in its own jacket and, if an inside envelope is included, don't throw it away—use it! Where only the cardboard jacket is furnished, it is wise to buy a cover made of soft plastic into which the record can be placed before insertion into the jacket. These plastic covers are made in 10- and 12-inch sizes and can be bought from record dealers or radio supply houses. The current retail price is about 10 cents each for the 12-inch size and somewhat less for the 10-inch ones. This price is low compared to the cost of replacing the record.

These covers accomplish a twofold purpose: they keep the records clean (more will be said about that later) and decrease surface damage. The inside of the cardboard containers is not completely smooth and as the disc is slid in or out of it abrasions may occur. The inside cover eliminates this possibility. (Never stack records one on top of the other without first placing them in their containers.)

Additional care is required in removing the record from the envelope and replacing it if an inside cover is not used. The best system is to press slightly at both ends of the jacket opening so that the sides are slightly bowed out. The record can then be taken out without too much rubbing



against the container. It can be replaced the same way.

One of the worst enemies of long-playing records is dust, the ordinary kind which accumulates to some degree regardless of all the means taken to prevent it. When dust has settled in the grooves, background noise and distortion occur whenever the record is played. The dust does not allow the needle to follow properly the groove variations which constitute the recorded sound, and noise is produced.

Storing the records in plastic or paper covers prevents much of the dust pickup which otherwise would occur. Dust can enter into a record cabinet, even with closed doors.

Vinylite has the characteristic that a static-electric charge is developed on the surface when it is rubbed with anything. The charge is strong enough to attract and hold particles of dust which may be lurking near the record. These static charges may be eliminated by spraying the surface with an anti-static fluid or by wiping with a rag which has been treated with the same type of liquid. Both are available at record dealers and supply houses.

These accumulated charges also cause some noise when the record is played, sounding like loud pops. Eliminating the static charge also reduces this type of noise.

The application of these anti-static compounds does not merely eliminate the dust present at that time; its effects last for many months and, after being treated, the record actually repels dust. Once the dust has gotten into the grooves, the pressure of the needle forces it deeper and it becomes all but impossible to remove.

Record handling

Proper handling can also help to prevent dust in the grooves. Our hands have oils on them in varying amounts, and when the grooves are touched with the hands a film of this oil is deposited on the record. This tends to hold any dust which is picked up. To prevent this, the hands and fingers should never touch the grooved area. The disc can be removed from the jacket and placed on the turntable by touching only the edge and the label area in the center. The user must be careful in doing this, but it pays off in increased record life and enjoyment. If the hands do touch the grooves, the residue can be wiped off with a clean, soft rag.

It is good practice to replace each record in its individual container immediately after playing, to prevent any damage which could occur if it is left out in the open. And of course, be careful never to drop a record or scrape it against some hard object which could cut into the surface.

If your turntable is not exactly level, the pickup arm may jump grooves and scratch the record. Or, if the record player is mounted or placed so that vibration can shake the tone arm, similar results can occur.

The stylus exerts a great influence on the amount of noise and distortion produced and also on the usable life of the disc. Three general types are in use: metal, sapphire and diamond, with the purchase price and dependability of operation increasing in that order.

As long as the stylus retains its roundness it wears the walls of the record grooves very little. But during use the stylus and disc are in constant contact so some wear occurs on both. The same stylus is used for all records, so any wear affects the stylus much sooner than an individual record. The sides of the stylus become flat and it eventually acts like a chisel, cutting into the record grooves.

Stylus wear begins to manifest itself through noise and distortion and, if allowed to continue, a disc may be ruined in one playing. It is true that some people buy a phonograph and never bother to change the stylus for years, and maybe the gradual increase of noise and distortion seems like a natural thing to them. If these same people were to hear a new recording played with a new stylus, on their own equipment, a valuable lesson would be learned. That is learning the hard way (also called the expensive method).

Metal styli usually begin to show signs of wear after only a few hours of playing. Sapphire needles last considerably longer and diamonds wear much longer than sapphire. If used regularly, a metal needle should be replaced every few weeks, a sapphire every few months and a diamond after several years. There is no such thing as a permanent needle, regardless of what the ads say. Of coursé, these rules have no great accuracy because the actual playing time varies considerably. One person may play records less than an hour a week, while others may play them for several hours each day.

As a general estimate, a metal needle should be replaced after about 20 hours of actual use and a sapphire after about 100 hours, and a diamond should last at least 10 times longer than the sapphire. So for long-run economy a diamond stylus, although its initial purchase price is higher than the others, outwears a large number of the other types and gives maximum protection to the record collection. It is poor economy to save a few dollars on the cost of a new stylus and waste many dollars in damaged records.

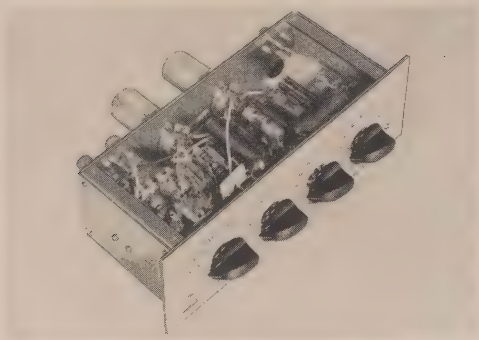
Keeping the stylus clean is also important. A small camel-hair brush will do a good job. And don't forget the stylus pressure. Too much and the stylus will dig into the groove, bringing the disc's life to an early end; too little and the stylus will skip, leaving scratches on the record face. If your pickup arm can be adjusted, keep stylus pressure between 2 and 8 grams. Check this frequently.

Record storage

Records should be kept in a closed cabinet, where dust entrance is kept to a minimum. And, if at all possible, the container should be in a comparatively dry place where heat is not allowed to become excessive. Moisture and heat are injurious as either can cause warping. Slight warping may show up only as small variations in record speed, called wows. If the warped condition is serious enough, the disc becomes unplayable because the needle will not stay in the grooves.

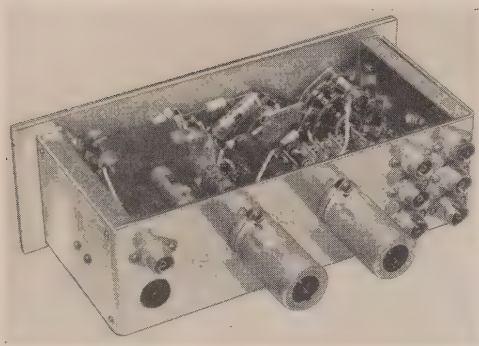
To minimize these possibilities, discs should be stored in an upright position, and preferably held together by other records, books or cabinet dividers. This insures that all the records will be straight and will be kept that way because of no room for bending. Laying them flat in piles is not as good as the upright position because, although the bottom ones are held down tight, those near the top could warp.

These rules sound like common sense, but a surprising number of record owners violate them consistently. By following them, the listener can get the most value for his record dollar, listening will be more enjoyable and free from noise and distortion, and long lasting. Dealers and technicians who instruct their customers in these basic facts will then enjoy the results of having customers who are more satisfied and, most likely, will receive increased business as a result. END



A new English design, this versatile 2-tube low-distortion unit will help you get the most from your amplifier

The finished preamp with the cover plate removed. Careful construction will give it a professional appearance.



A look at the back end of the chassis shows tube placement and positions of the input jacks.

CUSTOM PREAMP for your HI-FI SYSTEM

By E. J. PORTO *

POWER amplifiers with relatively high sensitivities—200 to 300 mv—offer many advantages in high-fidelity sound reproduction since the preceding preamp stages need not be of the high-gain type. Distortion, hum and noise levels, which are extremely critical in these stages, can, therefore, be kept to a minimum.

The Mullard preamp circuit[1] (see Fig. 1) was designed for use with such power amplifiers and is particularly suited to the Mullard 510 and 520 circuits. Inputs are provided for any type pickup, tape recorder playback heads, and microphone and radio tuner inputs. An auxiliary jack for any other input source convenient to the user is also provided. Equalization for disc recordings conforms to the latest RIAA characteristics, which have been adopted by most of the major recording companies. The tape playback characteristic is equalized to standard NARTB tapes.

Low-impedance tone controls with wide frequency coverage supply enough equalization for any application.

*International Electronics Corp., New York, N.Y.

[1]Design was originated in the Mullard Applications Research Laboratory, England.

How it works

The preamp has two stages, each using an EF86 high-gain pentode. All equalization takes place in the first stage and is controlled by frequency-selective feedback between the plate and grid of V1. There is no feedback in the second stage and V2's output is fed directly to a passive tone control network. This arrangement lets the input impedance of the first stage remain low. A low impedance at this grid reduces hum pickup as well as the effect of plugging in external low-impedance circuits. The arrangement also results in low gain in the first stage. This reduces Miller effect, between the plate and grid of the first EF86, which can be troublesome when high resistances are used in series with the grid.

Series resistors are used in the input channels so sensitivity and impedance of any channel can be accurately adjusted. The values given in Fig. 1 are for the most common inputs, but sensitivity and impedance[2] of each channel can be altered by changing the value of the appropriate series resistor.

The preamp's sensitivity can be changed for all input channels by varying V2's output. This is done by altering the ratio of resistors R21 and R22. (The sum of these two resistors should be maintained at 100,000 ohms.) The values of 18,000 and 82,000 ohms shown in Fig. 1 are appropriate for use with the 510 amplifier. With the 520 amplifier, and higher-powered types, output is taken directly from V2's plate.

Filter components R13 and C17 shown in the B-plus line should be included in the main amplifier rather than in the preamp. B-plus current drawn by the preamp is 3 ma at 320 volts.

Preamp performance

The values for hum and noise given for each input channel have been measured with the preamp connected to a Mullard 510 power amplifier. The measurements were made at the output of the power amplifier with the preamp's input terminals open. Frequency response curves were also determined with this combination of preamp and power amplifier. Sensitivity figures that follow provide outputs of 40 and 250 mv when V2's plate load is adjusted for use with 510 and 520 power amplifiers, respectively.

Pickup input channels

Equalization curves for the magnetic and the crystal pickup channels are shown in Fig. 2.

Magnetic pickup:

Input impedance:	100,000 ohms (approx)
Sensitivity at 1,000 cycles:	
(a) long playing	3 mv
(b) 78 rpm:	9 mv
Hum and noise	
(a) long playing:	55 db below 10 watts
(b) 78 rpm:	57 db below 10 watts

[2]The impedance of the input channels includes the grid impedance of the EF86 modified by the feedback components as well as the impedance of the input network.

R1, 2—2.2 megohms
R3—56,000 ohms
R4, 6, 19—1 megohm
R5, 28—68,000 ohms
R7, 15—100,000 ohms
R8—10 megohms, 5%
R9, 12—560,000 ohms, 5%
R10—5.6 megohms, 5%
R11—330,000 ohms, 5%
R13—30,000 ohms
R14—220,000 ohms, 5%
*R16—220,000 ohms
*R17—1 megohm
R18—2,200 ohms
R22—33,000 ohms
*R21—18,000 ohms
*R22—82,000 ohms
R23—1,200 ohms
*R24—390,000 ohms
R25, 29, 31—pot, 250,000 ohms, logarithmic taper
R26—47,000 ohms
R27—39,000 ohms
R30—6,800 ohms
All resistors ½-watt 10% unless noted
**Deposited-carbon low-noise resistors, 10% or better*
C1—390 $\mu\mu$f, silver mica, 5%
C2—150 $\mu\mu$f, silver mica, 5%
C3—.0022 μf, silver mica, 5%
C4—560 $\mu\mu$f, silver mica, 5%
C5—220 $\mu\mu$f, silver mica, 5%
C6, 10—25 μf, 12 volts, electrolytic
C7, 8, 11, 12—0.1 μf, 400 volts, paper
C9—8 μf, 350 volts, electrolytic
C13—560 $\mu\mu$f, silver mica, 10%
C14—.0082 μf, silver mica, 10%
C15—.0022 μf, silver mica, 10%
C16—.02 μf, silver mica, 10%
C17—16 μf, 350 volts, electrolytic
J1-7—phono jacks or coaxial connectors
S1—2-pole 6-position rotary, 2 decks
V1, 2—EF86
Aluminum sheets for chassis and case: 1—16 x 2½ inches; 1—9 x 3 inches; 1—8⅞ x 1 inches; 2—8⅞ x 3½ inches
Angle brackets 3¼ inches long, ½ inch wide in top and bottom corners (4)
Sockets, 9-pin miniature, with shields (2)
Knobs
Miscellaneous hardware

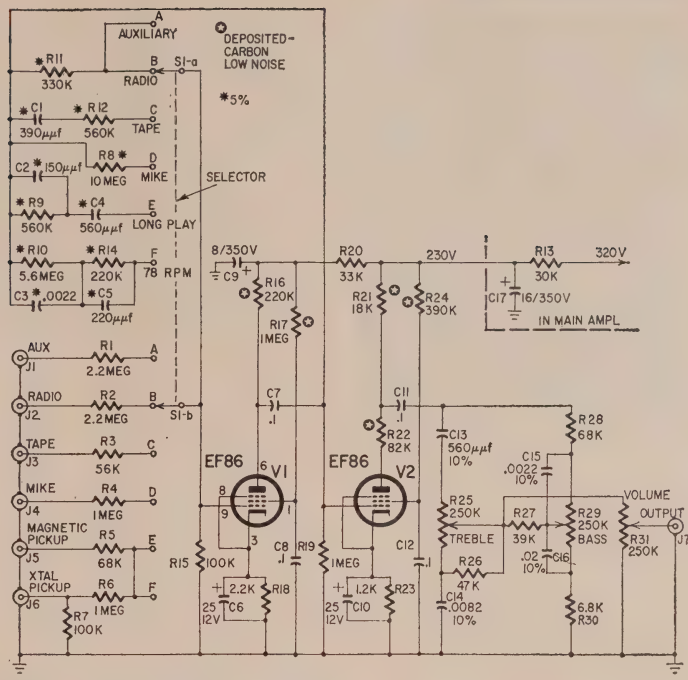


Fig. 1—Circuit of the custom preamp.

This input channel is best suited for variable-reluctance pickups, but moving-coil types which have higher outputs can be used if a larger value of series resistor (R5) is included. The difference in sensitivity between the long-playing and 78-rpm channels is taken care of by the amounts of feedback provided at positions E and F.

Crystal pickup:

Input impedance:	100,000 ohms
Sensitivity at 1,000 cycles:	
(a) long playing:	50 mv
(b) 78 rpm:	150 mv
Hum and noise	
(a) long playing:	55 db below 10 watts
(b) 78 rpm:	55 db below 10 watts

Low- and medium-output crystal pickups can be used for this channel. The input is loaded with 100,000-ohm resistor R7 so its characteristic approximates that of a magnetic cartridge and lets us use the same feedback network. This produces the best compromise with most types of pickups. However, if the pickup is not suited to this form of loading, or if its output is too high, it may be connected to the auxiliary input socket.

Tape playback input:

Input impedance:	80,000 ohms (approx)
Sensitivity at 5,000 cycles:	3 mv
Hum and noise:	52 db below 10 watts

The equalization characteristic used for this channel is shown in Fig. 3 and follows the NARTB curves. This channel is intended for replaying prerecorded tapes with high-impedance heads, and the characteristic adopted gives excellent performance. If greater sensitivity is required, resistor R3 can be decreased until the desired sensitivity is obtained.

Microphone input:

Input impedance:	1 megohm
Sensitivity at 5,000 cycles:	6 mv
Hum and noise:	44 db below 10 watts

The frequency response of this channel is given in Fig. 4. The microphone input channel is intended for use with high-impedance systems such as crystal or magnetic mikes with transformers.

Tuner input:

Input impedance:	2 megohms
Sensitivity:	250 mv

The frequency response of this channel is also given in Fig. 4. With the values of impedance and sensitivity quoted, this channel should meet most requirements. Other values can easily be obtained by changing feedback resistor R11 and series resistor R2. If the input impedance of the channel is too high, it can be reduced by connecting an appropriate resistor between the input end of R2 and the chassis.

Auxiliary input: The auxiliary channel is identical with the tuner input channel. This input, with the values shown in Fig. 1, can therefore be used for high-output crystal pickups or tape recorders. In addition, the channel can be easily adapted for many other applications. For instance, if series resistor R1 is reduced to 1 megohm, the auxiliary input will be suitable for crystal pickups which have low outputs.

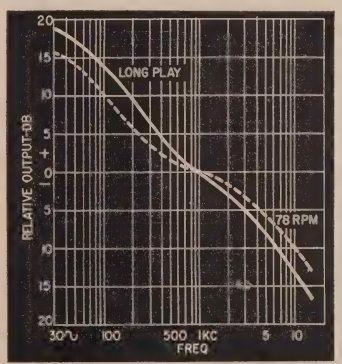


Fig. 2—Equalization characteristics of the pickup input channels.

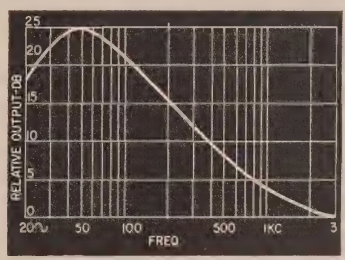


Fig. 3—Equalization curve for the tape playback channel.

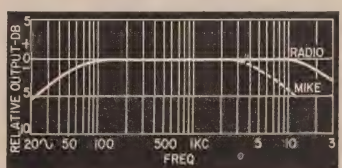


Fig. 4 — Frequency response of the microphone and radio channels.

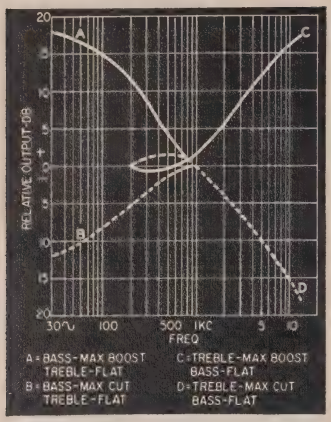


Fig. 5—Effect of various tone-control settings.

Tone control: The treble and bass control characteristics of the preamplifier are shown in Fig. 5. It is evident that an adequate amount of control is provided for almost any application.

Low-impedance controls have been adopted so that any capacitance resulting from long coaxial leads between the preamp and main amplifier will have a minimal effect on the preamp's output impedance.

Harmonic distortion: The total harmonic distortion of the preamp is less than 0.15% at normal output levels.

Construction details

The chassis and layout of the preamp have been designed specifically for the home constructor. A conventional box type chassis is not used. Instead, the chassis is made on the unit system, the separate parts being joined together during the assembly of the equipment.

The chassis is made up of five separate pieces of sheet aluminum. The dimensions are given in Fig. 6. Each piece should be marked as shown and the holes indicated cut. When bending the pieces, the scribed lines should lie exactly along the angles. This assures that the pieces will fit together properly when assembled. For ease of assembly, components should be mounted on two terminal boards, and these should then be bolted to the mounting strip before the strip is attached to the rear plate. Diagrams showing the position of the components on the terminal boards, and the appropriate connections are given in Fig. 7.

When the mounting strip and terminal boards have been attached to the rear plate, make all connections between the tube sockets and the components on the terminal boards. (Mount the tube sockets so that the tubes will be outside the completed chassis.)

Mount potentiometers R25, R29 and R31 on the front panel and connect the other components which make up the tone control network to them. Then bolt the front panel to the back panel and connect the remaining components.

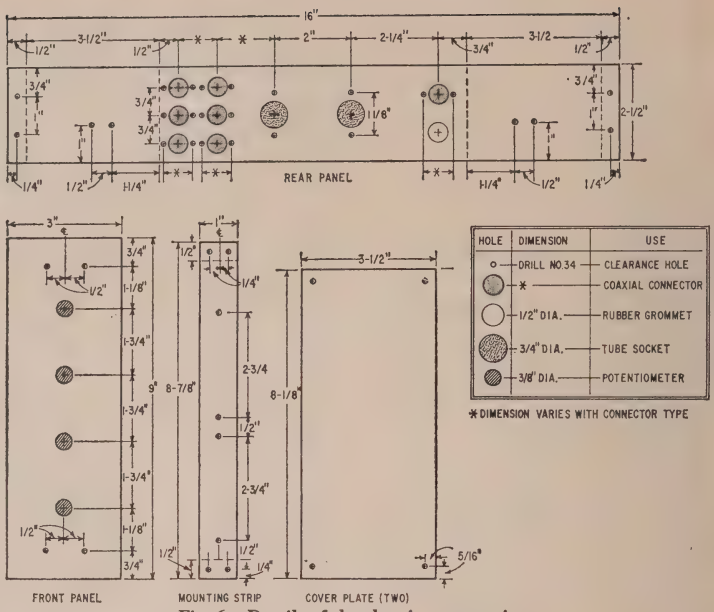


Fig. 6—Details of the chassis construction.

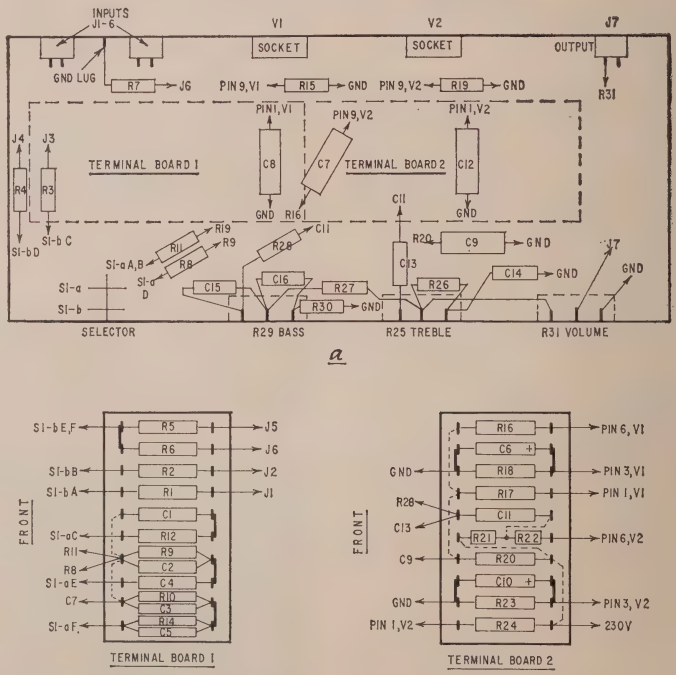


Fig. 7—Recommended parts layout; a—the main chassis; b—terminal board 1; c—terminal board 2.

The supply leads to the tubes should be taken through the grommet hole in the rear panel and soldered into position. To avoid the expense of a plug and socket, pass these leads through a small securing clip and knot them at this clip to prevent strain on the solder joints. When the wiring has been completed, fasten the cover plates in place with self-tapping screws. END

Reviewed by
CHESTER SANTON
Station WQXR, New York City

THE recording technique that gave the greatest impetus to high fidelity is now 10 years old. It was in June, 1948, that Columbia's research organization, CBS Laboratories, abolished some of the old record problems and instituted a few new ones with a 12-inch, 33⅓-rpm, unbreakable, Vinylite record containing up to 23-minutes of music on one side. The solution of problems connected with the 78-rpm speed enlarged enormously the audience for reproduced music. Technically minded listeners, some of them brought into the field by the LP record, devoted the money, time and patience needed to encourage the development of the microgroove record to its present stage of perfection. How good were the first LP discs? Only one decade later, the question is already difficult to answer because the earliest pressings are no longer on the market. Columbia's New York office generously offered listening facilities for their reference copies on the premises. I declined, however, in view of the unknown factors in playback. Luckily, the WQXR record library held copies of the original pressings going back to the first 12-inch classical disc—Columbia ML-4001. I proceeded to sample the first 12 releases put out on LP, using as reference my own familiar up-to-date sound system. The first remindful discovery (releases ML-4003 through 4011) were all devoted to Beethoven. Oddly enough, the first release (ML-4001) which contained the Mendelssohn *Violin Concerto in E Minor* with Nathan Milstein and the New York Philharmonic under Bruno Walter was found to have the best sound of the group. Next best was ML-4004 (Beethoven's *Piano Concerto No. 5* with Serkin and the New York Philharmonic under Walter). Technically, ML-4001 revealed the following: With equalization controls set for the Columbia LP curve and bass and treble in a "zero" position, rumble traceable to the record was audible. At normal listening level, reduction of the bass setting to "11 o'clock" on the dial removed most of the rumble. Upper frequency response was surprisingly good. Use of the 10-kc filter on my preamp reduced the highs by a minute amount, indicating the presence of some response above that figure. Response behavior when rolled off with the 7-kc filter denoted a flat curve in the area below 10 kc. In other words, filtering at 7 kc eliminated desired instrumental sound, whereas some subsequent LP records have used this same filter to flatten the recording curve's peak in that area. In a final gesture of curiosity, I switched to the RIAA position. It thinned out the sound. One clue to the acceptable sound on the first Columbia LP record was found in the timings. Side A ran 11:20; the other side 13:20. It is a better record than we suspected 10 years ago.

BRITTEN: *Young Person's Guide to the Orchestra*
DOHNANYI: *Variations on a Nursery Tune*
Felix Slatkin conducting Concert Arts Symphony Orchestra with Victor Aller, Piano
Capitol Stereo Tape ZF-23
(7-inch; playing time, 41 min. $14.95)

Perhaps stereo will serve as inspiration some day for another documentary score such as Britten's *Guide to the Orchestra*, composed for a British film demonstrating the instruments of the orchestra. In the meantime, this veteran display piece takes to stereo like a duck takes to water. The various sections of the orchestra undergo analysis new to recordings. The companion piece, Dohnanyi's spoof of other composers' styles, also receives excellent performance. The sound is a joy to unreel. The next time a neighbor inquires about the future wonders of stereo on discs, play him this present tape.

(Original Soundtrack Recordings)
South Pacific
RCA-Victor Stereo Tape GPS-109
(7-inch; playing time, 46 min. $18.95)
Raintree County
RCA-Victor Stereo Tape CPS-108
(7-inch; playing time 26 min. $10.95)

The transfer of motion-picture soundtracks to commercial records used to present a problem. The unique film recording curve made much of the middle frequencies, disregarded the intensity of the other frequencies. Happily, the first stereo appearance of the original soundtrack recordings of *South Pacific* and *Raintree County* follows the new trend toward wider-range sound. The added spaciousness of stereo heightens the illusion of a present-day movie in your living room. Not a movie-goer, I found the going rather heavy.

TCHAIKOVSKY: *Symphony No. 6 in B Minor*
Dimitry Mitropoulos conducting New York Philharmonic Orchestra
Columbia Stereo Tape LMB-19
(7-inch; playing time, 40 min. $15.95)

Except in the line of duty, I see no reason ever again to listen to the *Pathétique* in monophonic reproduction. Despite the urgent pace of Mitropoulos, it is a revelation to follow so easily the simultaneous strands of music voiced by instruments in all sections of the orchestra. The sound—controlled warmth on a wide front.

Viva!
Percy Faith and His Orchestra
Columbia Stereo Tape GCB-15
(7-inch; playing time, 21 min. $10.95)

Quite a splash of sound in this music of Mexico, heard here in highly polished arrangements. Percy Faith has always taken a keen interest in the engineering accorded his recordings. Jaded ears are sure to perk up at these refreshing treatments of old favorites such as *Mexican Hat Dance, La Cucaracha, Granada, etc.*

WAGNER: *Die Meistersinger* (concert version)
Carl Bamberger conducting Frankfurt Opera Orchestra and Chorus
Concert Hall Society Stereo Tape RX-62
" " (Two 7-inch; playing time, 1 hour 40 min. $23.90)

Opera in stereo is being listened to by only a handful of persons at the present time. This is due for a change in the near future as better casts are employed and lower priced stereo is developed on tape and disc. At the present, Concert Hall deserves credit for tackling opera at all. When the imaginary curtain rises on *Die Meistersinger's* first scene—as set by a wide-range stereo system—the three dimensional opera-house effect forces one to forget that the soloists are relatively stationary in this concert version. Mild division of sound places some soloists in one channel, the major part of the orchestra in the other. A vast acoustical domain tends to pull them together. When lower-priced tapes permit full-length recordings of top casts, opera will be stereo's crowning achievement.

Marching Along
Frederick Fennell conducting Eastman Symphonic Wind Ensemble
Mercury Stereo Tape MWS 5-14
(7-inch; playing time, 16 min. $6.95)

Matches in sonic appeal the spectacular *Ruffles and Flourishes* tape of Fennell reviewed in May. Here the same crisp, ultra-wide-range recording techniques are applied to brasses, winds and percussion of the Eastman Ensemble led in six favorite Sousa marches. At the top of the list for demonstration of traditional band music in stereo.

The Feathery Feeling
David Carroll Orchestra
Mercury Stereo Tape MVS 2-19
(7-inch; playing time, 17 min. $7.95)

Sugar and spice in a new mixture. A light-stepping type of dance music, with choral backing and electric organ helping the orchestra in the slow numbers. The miking in a very bright studio is plotted out in subdivisions. The two overall stereo microphones are aided by three separate closeup mikes, one each for piano, bass and drums.

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

The Reiner Sound
Fritz Reiner conducting Chicago Symphony Orchestra
RCA-Victor LM-2183

This disc is a current favorite when demonstrating the absence of coloration in my latest woofers. The singular qualities of extremely low orchestral bass captured in Ravel's *Rhapsodie Espagnole* are truly apparent only on woofers whose flatness of response matches that found on the record. *The Reiner Sound* should help resolve differences of opinion concerning the merit of the most recent woofer designs.

SCHUBERT: *Symphony No. 7 in C Major*
George Szell conducting Cleveland Orchestra
Epic LC-3431

Also known as the *Symphony No. 9*, this monumental work, Schubert's last in this form, receives at last a recording whose sound is worthy of its stature. The Cleveland orchestra has always enjoyed the advantage of exceptional hall acoustics. Each movement in this release, set forth with admirable clarity and style by George Szell, gives us a chapter of what amounts to a textbook on proper use of good acoustics.

DVORAK: *Symphony No. 4 in G Major*
Scherzo Capriccioso
Sir John Barbirolli conducting Halle Orchestra
Mercury MG-50162

In its technical aspects, this release surpasses the Angel version which has headed the list in recent years. Although the Halle performance misses some of the Czech idiom found in other versions, Mercury's closer miking reveals for the first time the inner voices of the orchestra. Fabulous presence—no exaggeration of recorded dynamic range. The ingenious, daringly scored *Scherzo Capriccioso* promises to be one of the leading demonstration items of the day. Very highly recommended for the very finest systems.

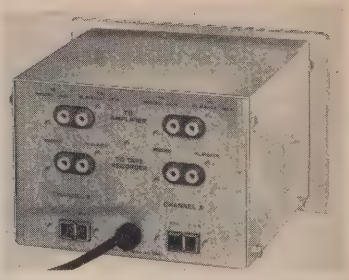
Francescatti Plays Kreisler
Columbia ML-5255

Such Kreisler favorites as *Caprice Viennois, Tambourin Chinois* and *Schön Rosmarin* played by Zino Francescatti in this updated pressing. Pickup is on the distant side, resulting in concert-hall projection of the violin's sound under controlled studio conditions. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N. Y.*

an EXPAND-to-STEREO unit

Compact unit helps you add stereo to your present hi-fi system



Rear view of the control unit shows the few connections needed to put it in service.

THE high-fidelity fan who is looking for a gadget that will help him convert his present system to stereo will be interested in the H. H. Scott Stereomaster Control Center (Stereo-Daptor) model 135. It is designed primarily for that manufacturer's equipment, but can also be used with any system that uses separate preamps and power amplifiers. With the Stereo-Daptor you don't need a special stereo preamp or amplifier. The equipment you now have handles one channel while a new unit takes care of the other.

When a Stereo-Daptor becomes part of a hi-fi system, it provides for a variety of arrangements—stereo tuner, stereo tape, stereo phono or monaural record and playback. One typical hookup is shown in the diagram.

Here's how it works. The unit's master volume control simultaneously adjusts the levels of both stereo channels, and a master switch ganged to this control turns the amplifiers on and off. Loudness compensation can be switched in if desired. The Stereo-Adaptor's selector switch provides for five modes of operation. In the first position, MONAURAL RECORDS, both main amplifier inputs are paralleled through a resistor network. In the STEREO position, either tuner, tape or disc stereo sources provide a stereo program. The REVERSE STEREO position lets you reverse the channels (left channel to right speaker, and vice versa) without juggling interconnecting cables around. Last are the CHANNEL A and CHANNEL B positions. When set here, only the one channel selected is heard. This channel is played through both amplifiers and speakers, and is especially convenient when playing from monaural radio, tape or record sources.

If a stereo cartridge is used, monaural records may be played in the STEREO as well as theMONAURAL RECORDS position. However, when playing a monaural disc with a stereo cartridge the MONAURAL RECORDS position should be used, since at this setting the unwanted vertical components are combined out-of-phase and are thus cancelled.

END

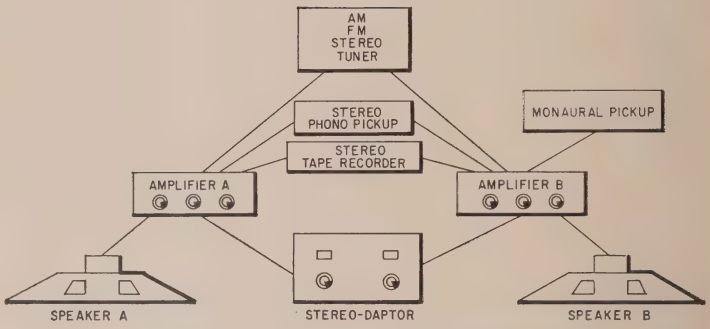


Fig. 1—A general stereo hookup using the Stereo-Daptor.

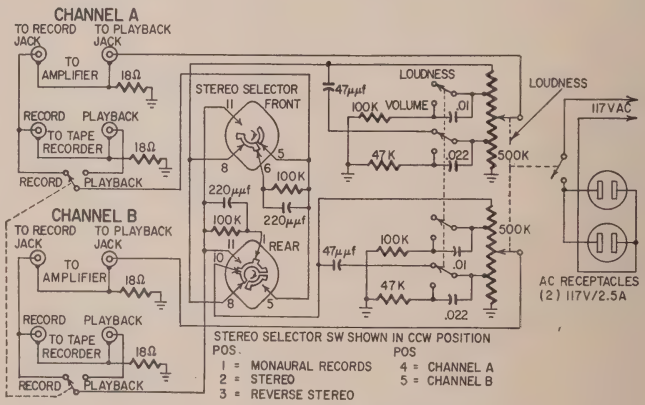
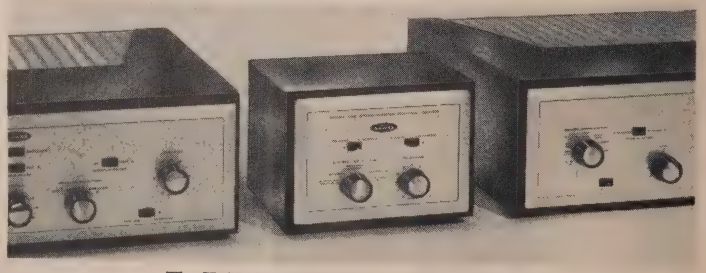


Fig. 2—Circuit of the Stereo-Daptor



The H. H. Scott Stereomaster Control Center

HORIZONTAL ringing

How to clear up this common TV trouble

By JESSE DINES*

A FAULTY component part, improper dc operating voltage or a component mismatch in the horizontal output (or flyback) circuit could cause one or several vertical bars to appear on the TV raster. These bars may be caused by *ringing* or an improperly shaped horizontal sweep signal. Ringing refers to damped oscillations which are generated in an L-C tank circuit. Specifically, any inductor in the flyback circuit (including the yoke, flyback transformer, width coil and linearity coil) will resonate with its inherent stray and distributed capacitances, usually at a frequency from 70–90 kc.

Ringing caused by the horizontal yoke windings is the most common type. It is viewed as a series of vertical light–dark bars on the left side of the raster which diminish gradually toward the raster center (Fig. 1). (The cause and elimination of this ringing are discussed later.) Ringing due to the other inductive components in the flyback circuit takes the form of one (and sometimes two or three) vertical bars which may appear anywhere on the raster.

Ringing is more noticeable in a raster than a picture. Therefore, when eliminating it always work with the raster. Simply remove the video output tube to get rid of the picture. Once ringing is minimized to the point where it is hardly noticeable, it will not be seen at all when the video is restored.

*Author "Servicing TV Sweep Systems."

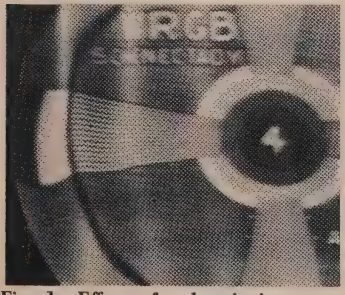


Fig. 1—Effect of yoke ringing on a television picture.

When a vertical bar appears at the left center of the raster, it is not likely that the trouble is due to ringing. It is a slight foldover caused by an improperly shaped yoke current trace. Fig. 2-a shows a yoke current trace which is normal by virtue of its linearity. Fig. 2-b shows the trace with a dip in it. The dip causes the yoke's magnetic field to become distorted, resulting in the electron beam in the C-R tube slowing down at this point, causing foldover.

The dip occurs when the horizontal output or damper tubes do not start and stop conducting at their predetermined times or when either of these tubes conducts more or less heavily than normal. Fig. 2-c shows how the horizontal yoke current is formed. The current through the yoke is the resultant of the horizontal output and damper tube currents. For the current to be linear, these tubes must start and stop conducting at the designated intervals. For example, if the damper tube stops conducting too soon, then the resultant yoke current will dip in the trace portion as shown in Fig. 2-d. A dip will also occur if the current magnitude of either tube is improper. Fig. 2-e shows such a dip when the horizontal output tube is conducting lower than normal. Note that, if the trace had two or three dips, there would be two or three vertical bars.

The horizontal linearity coil controls simultaneously the plate voltage of the horizontal output tube and the cathode voltage of the damper tube in the interval when the yoke current is formed. Therefore, an adjustment of this control will sometimes eliminate a vertical bar.

An improper operating voltage (such as drive, B plus, boost, screen and filament) or a mismatch in the circuit (especially between the yoke and flyback transformer) is likely to cause

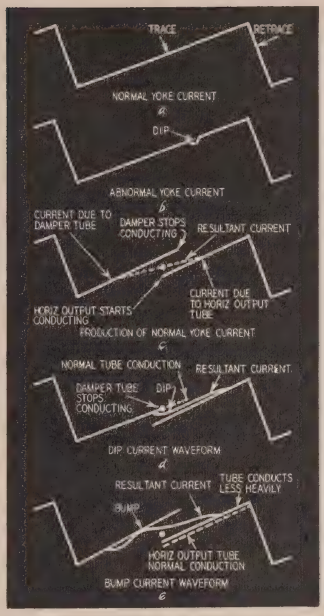


Fig. 2—Normal and distorted waveforms of horizontal yoke current.

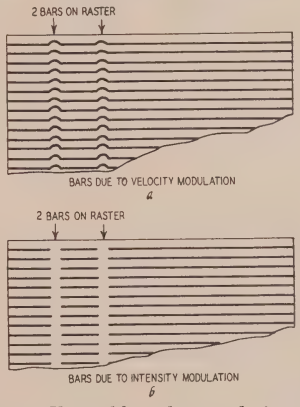


Fig. 3—Vertical bars due to velocity and intensity modulation. Enlarged view.

improper conduction of the horizontal output and damper tubes. This, too, could cause a vertical bar. Thus, an improperly adjusted horizontal drive control will result in that ever-familiar bar at the left center of the raster.

Velocity and intensity modulation

Vertical bars appear on the raster via the distorted magnetic field produced by the horizontal yoke. The magnetic field modulates the C-R tube electron beam, and this is known as *velocity* modulation. Sometimes bars appear on the raster, due to *intensity* modulation. That is, the spurious oscillations generated in the flyback circuit are radiated into the video sections of the receiver. There they are fed to the

C-R tube gun circuit where they intensity-modulate the beam current.

A close look at how the lines of the raster look when velocity and intensity modulation occur is given in Figs. 3-a and 3-b. For velocity modulation, each raster line contains dips (due to distorted sweep trace) with the result that two bars appear after one complete scanning cycle. In intensity modulation, the gun beam is cut off at two points as indicated, which results in the bars.

If the type of modulation cannot be determined by close observation, then it may be found by carefully shielding the high-voltage section of the receiver to note if the vertical lines disappear. If they do, then intensity modulation is causing the trouble. Shielding the tubes in the video sections of the receiver will also eliminate bars due to intensity modulation. Shielding *cannot* eliminate those due to velocity modulation.

Yoke ringing

Ringing due to an unbalanced condition of the horizontal yoke windings is fairly common in the flyback circuit. That is, if the horizontal yoke windings do not have equal impedances, they will not be a proper match for the flyback transformer. In turn, the improper match will result in vertical bars, due to a distorted sweep trace, or ringing as shown in Fig. 1 will result. The reason for the ringing is that, because the mismatch results in improper loading for the damper tube, the damper tube cannot perform its function fully and remove damped oscillations which inherently exist in the flyback circuit.

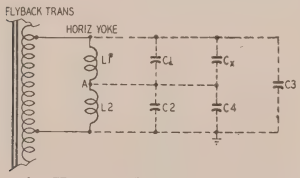


Fig. 4—Horizontal yoke windings showing distributed and stray capacitances.

Refer to Fig. 4 to see why the horizontal yoke windings must be balanced. L1 and L2 are the high and low horizontal yoke windings shown connected to two tap points on the flyback transformer. Point A represents the electrical center, or *balance* point of the yoke, C1 and C2 the distributed capacitances of L1 and L2, C3 and C4 the corresponding stray capacitances of the windings.

Assuming that L1 equals L2, then $C1 = C2$ and $C3 = 2 \times C4$. The total capacitance across L2 is $C2 + C4$ and the total capacitance across L1 is $C1 + \frac{1}{2}C3$. Thus, the yoke is not balanced, since these capacitances are not equal. To make them equal, an additional capacitor C_x must be connected across L1, as shown in Fig. 4. C_x is made to equal C4 (or $\frac{1}{2}C3$), balancing the yoke.

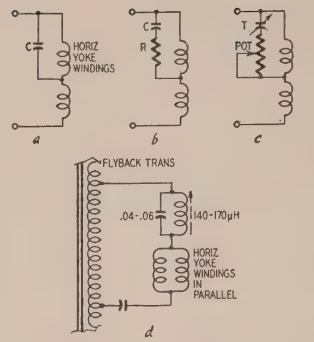


Fig. 5—Methods of eliminating ringing caused by the horizontal yoke windings.

Ringing may be eliminated from a yoke by first removing the balancing capacitor across the horizontal yoke high side (C in Fig. 5-a) and the resistor in series with it (R in Fig. 5-b), if one exists, and then substituting a trimmer capacitor and potentiometer for these as shown in Fig. 5-c. The trimmer and potentiometer are varied for minimum ringing while observing the raster. At this point, the capacitance and resistance values are measured and fixed components are substituted in their places. The final reading of the potentiometer will usually fall between 500 and 2,000 ohms and that of the trimmer between 30 and 120 $\mu\mu$f.

This method cannot be used for those yokes which have their horizontal windings connected in parallel. It can be used for yokes which employ center-tapped horizontal windings, provided that the original yoke uses a balancing capacitor.

Another effective way to remove yoke ringing is to insert a series resonant trap as in Fig. 5-d. Typical values of the inductor and capacitor are indicated. The trap resonant frequency is about 75 kc. For best results, different values of inductors and capacitors should be tried. The inductor may be a heavy width or linearity coil.

Flyback transformers

The windings of the flyback transformer may resonate with its inherent

Fig. 6—Negative overshoot at horizontal output tube plate causes ringing.

stray-distributed capacitance to produce ringing. This usually results in a lowered high-voltage output and sometimes insufficient width. This ringing may be observed at the plate of the horizontal output tube (Fig. 6.) Note the relatively large negative overshoot which does not normally exist. The ringing can be eliminated by inserting an R-C filter network in series with the high-voltage lead (Fig. 7-a) or an L-C-R filter network (Fig. 7-b) if the set does not already have one. In this case, the inductor may be a variable rf choke or coil.

A flyback which is mismatched or does not have a proper operating voltage can cause one or several bars. This condition can result if the core saturation of the flyback is not proper; a slipped, cracked or chipped core can cause drive lines. Fig. 8 shows a TV raster with a vertical line in the center, due to an improper air-gap width. The proper air gap can be inserted into a core by separating its two segments with a pair of long-nosed pliers and then inserting a piece of ordinary tape of the desired width. Extreme caution must be taken while separating the segments, since the flyback winding can easily be damaged.

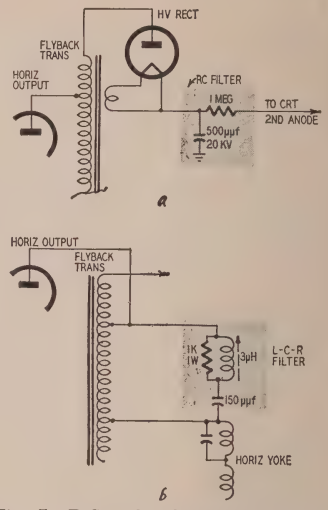
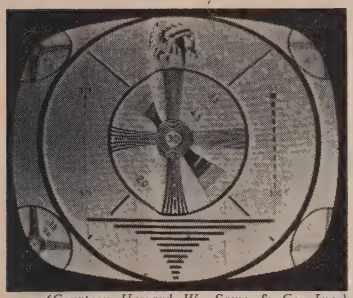


Fig. 7—R-C and L-C-R filter networks to remove ringing.

The width and linearity coils are connected in the flyback circuit so that they form isolated adjuncts to the horizontal output circuit. Thus, they resonate easily with their stray and distributed capacitances when shock-excited by the pulses in the flyback circuit. The result is ringing. Placing a damping resistor of about 1,000 ohms across the coil which is ringing should remove the oscillations. If it doesn't remove them completely a new coil should be substituted.

Barkhausen and "spook" oscillations will also cause vertical bars. Barkhausen results from the spurious oscillations of the flyback transformer winding during the time when the horizontal output tube plate is negative with respect to the screen. The oscillations are picked up by the front-end and video stages of the receiver where they ultimately intensity-modulate the C-R tube electron beam. Barkhausen appears as one or more vertical black lines at



(Courtesy Howard W. Sams & Co. Inc.)

Fig. 8—Effect of ringing caused by improper flyback transformer air gap.

the extreme left or right of the picture. The presence of Barkhausen may be noted by the large negative overshoot which is seen in the horizontal output tube plate waveform, similar to Fig. 6.

The "spook" takes the form of a vertical line or band at the extreme left of the picture. With strong picture signals, the vertical line is grayish and has crawling diagonal lines within the line's margins. With weaker picture signals the vertical line is very black and has ragged edges. The diagonal lines are caused by the heterodyning action of the incoming signal and the spook oscillation. This oscillation is caused by the damper tube and its associated leads and components. Just like Barkhausen it intensity-modulates the C-R tube electron beam.

Barkhausen and spook oscillations are very similar. To differentiate between them remember that Barkhausen is strongest on high-frequency channels, spooks on low-frequency channels.

Both types of oscillations may be eliminated in more or less the same way. Increase the signal-to-noise ratio of the TV receiver by reorienting the antenna, using new tubes in the front end, alignment, etc. Readjust the width, drive and horizontal linearity controls. Try several horizontal output (for Barkhausen) and damper (for spooks) tubes. Insert 47- or 100-ohm carbon resistors and 10-μh chokes in series with the horizontal output tube's screen and control grid (for Barkhausen) or in series with the plate and cathode of the damper tube (for spooks). END

PARALLELED RESISTORS CAUSE TVI

By JAMES A. McROBERTS

THE practice of paralleling resistors (to lower the combined resistance or to increase heat dissipation) is not always satisfactory in uhf equipment, and it is advisable to check all channels on a TV set after paralleling components. This apparently innocent practice can result in parasitic oscillation affecting a channel with the customary signs of interference. Moving a metal object or the hands in the vicinity of the parasitic circuit changes the interference symptom from a grain to a bar type pattern.

The case was a Sparton 29U213 chassis. The repair that caused the trouble was the use of two parallel carbon resistors to replace the original part. Each resistor has inductance and capacitance (Fig. 1). C and L1 are within the body of the resistor, L2 and

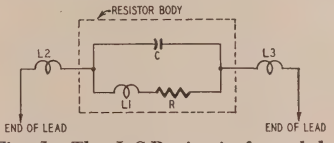


Fig. 1—The L-C-R circuit formed by each resistor.

L3 represent lead inductances. The combination of the two resistors with their distributed properties forms the circuit of Fig. 2. This is equivalent to a damped tank circuit. The two resistors were installed in the plate load (Fig. 3) of a sync inverter.

The original trouble was due to a short-circuited tube (V17-b) which burned the plate load resistor. The service technician replaced it with two resistors which restored the set to apparently normal operation (he failed to check all channels) and the set was returned to the customer. The customer complained of TVI on channel 13 and the set was returned to the shop. I was requested to find the source of the TVI.

A short length of wire was connected to the antenna terminal and the set turned on. Moving the antenna lead about the underside of the chassis while watching the TVI on the screen

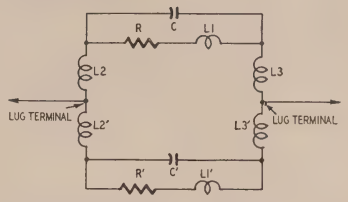


Fig. 2—Equivalent circuit of the combined L-C-R values of the two resistors.

disclosed a maximum of intensity near the two replaced resistors. Replacing the paralleled combination with a single resistor eliminated the trouble completely. No further complaint has been received from the customer. Moral: Check all channels of a TV set prior to delivery even after the most simple repair.

The theory is that the pulsed voltages in the sync inverter shocked the resonant circuit into oscillation. The value of the resistance in series with the resonant circuit was low enough to permit it to oscillate. Sufficient radiation existed for an appreciable amount

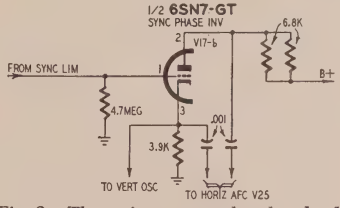


Fig. 3—The resistors were the plate load of a sync inverter tube.

of the oscillatory energy to reach the tuner input where it formed an interference pattern with the incoming signal on channel 13. Presence of the symptom at the customer's home and the shop (two widely separated places) almost definitely pointed to trouble within the set instead of general neighborhood TVI. The attached antenna wire proved the point as well as localizing the interference. END

NEXT MONTH

Designing a Low-Distortion 12-Watt Amplifier

A medium-power amplifier sufficient for all the needs of the average music listener.

New Tuners Feature Lower Oscillator Drift

The more important and outstanding features of current TV tuners.

Wet Thermistor Relative Humidity Meter

The electronic thermometer is already well established—now we have an electronic humidity meter.

TRANSLATORS... television's last frontier

They bring programs to many "hidden valleys," which would otherwise be without TV. Here we have a rapid, but detailed, look at what the translator is and how it works

By ROBERT B. COOPER, JR.

DESPITE the 500-odd television stations in operation in the United States, several problems of primary coverage still exist for the general public who want television and the station operator who wishes to extend his coverage into shadow and fringe areas.

Although just about every major and secondary population center is currently within range of one or more television stations, many pockets still exist in which no reception is possible, due to the thoughtlessness of nature and the schemes of man who has located towns deep in mountainous valleys. In some of these valley towns television is a cabled product, sold to the viewers much as the street merchant peddles his wares. If you want it, you pay for it. If you don't pay for it, you don't see it!

Boosters vs translators

In the mid 50's, many communities in the northwestern states found good television reception possible on the mountain peaks surrounding their valley towns. To the people living in valleys, the problem seemed merely to be one of getting the strong signal from the mountain top to the town below. In most instances cable system estimates were too expensive for the number of receivers to be served. A very simple answer was the use of two antennas and a commercial booster unit.

One antenna received the distant signal, fed it into the booster unit, and then retransmitted it by the second antenna. These ½-watt units often produced fair to good results over small areas, although technical problems such as isolation of the receiving antenna from the retransmitting antenna, etc., were seldom solved. Thus feedback, etc., did much to damage the rebroadcast quality. Coupled with the poor general quality, FCC engineers took a dim view of such proceedings, emphasizing that such booster stations were unlicensed and constituted a violation of the channel assignments in a given area. More than 200 of these units are thought to be in use today.

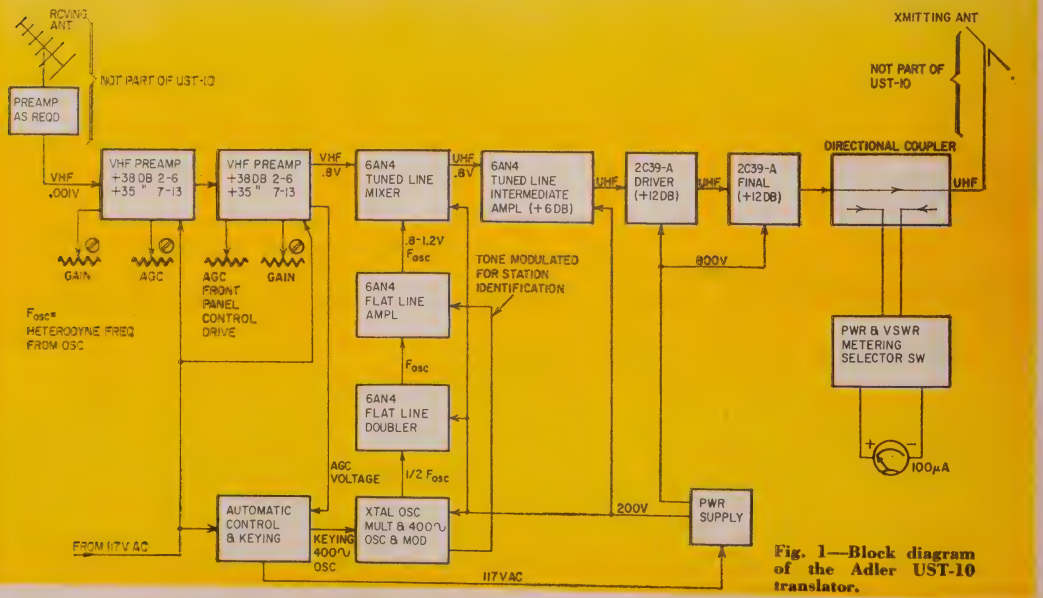


Fig. 1—Block diagram of the Adler UST-10 translator.

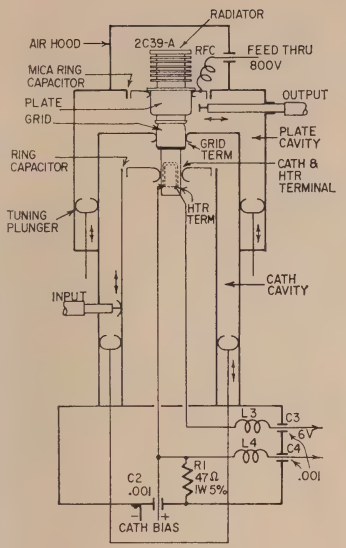
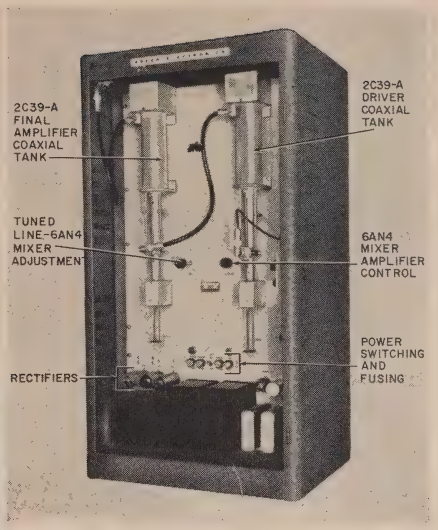


Fig. 2 — A combination electrical–mechanical drawing shows the appearance of the translator's output stage.



Front view of the UST-10 translator with the door removed.

(Left) Unitized transmitting antenna without weatherproof housing.

In 1955, the FCC announced to the not too startled industry that they had uncovered and shut down several illegal mountain-top booster stations, designed to rebroadcast a distant signal into a populated valley area. The FCC declared that such operation was not in keeping with the basic FCC allocation plan for the country nor was the technical competence of the majority of the installations worthy of FCC approval. But a spark had been kindled, the people had demonstrated that they were ready to go to extreme measures to receive television—anything but paying for it on a cabled system.

Following a year and a half test run by RCA, independent television stations (WSM-TV, Nashville) and various other interested parties, the FCC adopted a method by which a low-power repeater–converter unit could be located in a position favorable to a shut-in valley, convert the outlying vhf (or uhf) signal to one of the highest uhf channels currently in use (channels 70–83), amplify it according to rigid specifications and rebroadcast the "new" signal to the valley below. The *translator* was born.

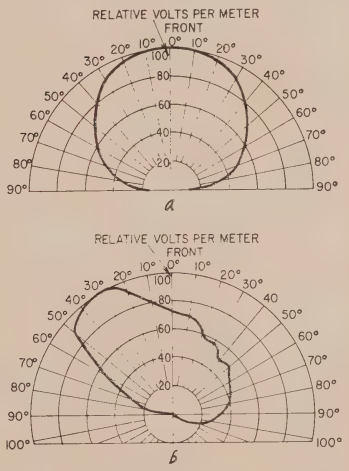
What is the translator?

Basically, the translator, made by Adler Electronics, Inc., combines the features of a very compact, self-contained television station (which is neither able nor licensed to originate any programming whatsoever) and a mountain-top repeater, similar to those used for mobile communications services throughout the country (see Fig. 1). About 130 are in use in the US, servicing an estimated 600,000 people. Additional translators are currently operating in Mexico, Canada, Brazil, Cuba and Guam. Later in the year, Korea will be added to this list.

With a vhf input signal of 1,000 μv or more, the Adler UST-10 translator mixes the received signal through a carefully designed crystal-controlled converter to a vacant, FCC-assigned channel in the upper uhf range, where it is amplified in a high-efficiency coaxial tank circuit using a 2C39-A transmitting tube.

The output of this driver–amplifier drives a second 2C39-A in a final amplifier stage (see Fig. 2), also of coaxial tank design, which has a rated output of 10 watts video carrier and 5 watts audio carrier. The output is fed through low-loss coaxial cable to a specially designed unitized weatherproof antenna. Each unit of this antenna is made up of four elements (four dipoles, with plane reflector) giving a 9-db gain over an isotropic radiator, on a pattern 100° wide at the half-power points. Through the many available antenna patterns, achieved by stacking a number of four-element units, ERP (Effective Radiated Power) values may reach 500 watts in the desired direction, providing more than adequate signal for snow-free reception with a simple receiving antenna, at a distance of 30 miles, under suitable terrain conditions.

Fig. 3 (below)—Antenna patterns: a — pattern obtained using one standard utilized antenna unit. The horizontal width at half-power point is 100° and has gain of 9 db; b—uneven power splits, to favor unusual terrain problems, are possible if special power-splitting transformers are used with multisection unitized antenna.



Translator installation at Blythe, Calif.

Translator circuitry

The standard Adler UST-10 provides sufficient vhf amplification to operate with full uhf output with as little as 1,000 μv, across a 75-ohm input. Additional vhf preamps can be added externally to build up the signal to the required level for retransmitting. An agc stage in the built-in preamp allows a signal variation of 20 db (fading, etc.) without a measurable fluctuation in the output of the 2C39-A final stage. A keying device built into this stage automatically turns the transmitter on and off with the base station it is rebroadcasting, and gives the translator's assigned call in International Morse code at predetermined intervals.

Conversion from vhf to uhf is performed at a high level, eliminating the problem of uhf noise generation in the mixer. The mixer uses a 6AN4 operating in a grounded-grid circuit to provide stable intermodulation-free operation.

Three separate linear amplifier stages are used to amplify the aural and visual signals from the mixer's output. Under the specifications laid down by the FCC, bandwidth and linearity of the retransmitted signal must be essentially identical to that of the received vhf station, maintaining the high quality enforced at broadcasting stations.

Facilities are provided for measuring the unit's power output and VSWR with a simple portable service meter (such as a Simpson model 260), and metering jacks are also made available for checking out other stage operations. Under FCC law, a remote control line on the ac supply to the translator must be provided. The UST-10 takes care of this with a simple two-conductor control cable running down the mountainside to the nearest operating technician. (This is an emergency measure to insure equipment shutdown in the event that some trouble develops that does not automatically shut the translator down.) The unit draws 420 watts from a 60-cycle single-phase 117-volt ac line during transmitting periods.

Antenna installations

The receiving antenna is normally a simple Yagi array for the desired channel.

The transmitting antenna, however, is a product of the Adler Co., and almost any conceivable radiation pattern may be incorporated through special stacking arrangements. This allows for good coverage in any of the oddly shaped valleys found in mountainous areas. Two of the many antenna patterns available are shown in Fig. 3.

Uhf to uhf

As mentioned earlier, the translator also provides an answer to coverage-minded television station operators, in filling in nulls and shadows in their coverage areas. For example, in June, 1957, station WWLP, Springfield, Mass. (uhf channel 22), put a repeater unit into operation at Claremont, N. H., as the nation's first station-owned translator unit. At that time, four or five additional Adler units were scheduled for operation in Vermont and New Hampshire in the near future (under WWLP's auspices).

In uhf-to-uhf operation, crystal-controlled converters first convert the uhf signal of the commercial station to a vhf channel. Then the signal is amplified and agc is applied. Next, it is mixed back to uhf again, this time to the high end of the band. The double conversion is used to obtain the necessary gain through amplification at vhf frequencies, and to take advantage of the stability obtainable at lower frequencies.

To date, over 150 translator units have been ordered and installed, or are in the process of installation. Most of these units are used in the Rocky Mountain states and along the West Coast. The units are housed in small unimpressive "shacks" whose only virtue seems to be their ability to withstand being blown clear off these wind-swept peaks.

Power for the unit sometimes presents a problem, as it has to be piped in from some distance away. Normally, this is as large a cost as the actual translator unit itself. Support poles for the receiving and transmitting antennas must be rigid and well anchored in most areas to protect them from the elements. Receiving antennas often are specially built of 1-inch (or larger) diameter tubing, as anything smaller is ripped to shreds by wind, rain and snow. The transmitting antenna is housed in a Fiberglas weatherproof housing, and once mounted and positioned, needs no further attention.

What does it cost?

From small areas comprising 300 people to larger shut-in towns with 25,000 potential viewers, the cost of a translator installation is normally very small—averaging $6,000 per channel—when compared with other systems, such as cabled TV. Additionally, more translator units may be added to the original unit for the rebroadcasting of other channels. With three such units, to serve an area located some miles from a large city having separate stations for each of the three network affiliations, the shut-in area can enjoy television from each of the three major available networks.

In most instances, town or city governments, local contributions, fund raising campaigns, etc., are used to get the money to pay for the installation. In some instances, a few business-minded appliance dealers will band together to raise the necessary capital in return for the TV sales and service brought on by the advent of television to the area. In no time at all, the unit pays for itself, regardless of how the initial cost is met.

In almost every instance, the installation of a translator has meant television in what was a completely virgin area. This means a goodly number of set sales, installations, and some fast boning up on uhf signal propagation, antenna installation, etc. In short, the translator is opening new horizons to the service technician, filling in blind spots, and helping bring closer the day when television will be truly available to every American family, whether they live in downtown Manhattan, New York City, or downtown Manhattan, Nev. END

There are many kinds of crosshatch generators, but there are some that make convergence harder instead of easier

Fig. 1—Red explained that the generator pattern was distorted at the top.

more crosshatch generators

By ROBERT G. MIDDLETON
TELEVISION CONSULTANT

I SEE you're pushing a new car around," Bess remarked.

"Yeah, the ashtrays were getting full on the old one," Fuzzball replied. "How's for a cup of java?"

Fuzz turned to Red. "Do you know there's more kinds of white-dot and crosshatch generators than Carter has pills?"

"There's quite a few different kinds," Red agreed.

"Old Fatpants just ordered one that plugs onto the base of the picture tube," Fuzz advised.

"So I hear."

"What's the scoop on this generator?"

"Well," Red replied, "the kind you mention has a high output at video frequency. It puts out enough sock to drive the picture tube directly."

"What do you want to do that for?"

"Sharper dots and finer lines," Red replied. "When the pulses don't have to go through the receiver circuits, you get a cleaner pattern."

"Are you just filling my ear with smoke?" Fuzz demanded.

"Look," Red answered, "what's the bandwidth of the signal circuits in a color receiver?"

"Somewhere from 3 to 3.5 mc."

"Right. What does that mean to you?"

"I see what you're driving at," Fuzz announced. "A narrow pulse has a wide bandwidth. If the pulse is real narrow, the signal circuits will smear it out more or less."

"A remarkable deduction," Red replied grinning. "But if we drive the picture tube directly, we can get a bandwidth up into hundreds of megacycles, if we want to."

"I don't like it," Fuzz said.

"I like that new car you got," Bess interjected coyly.

Fuzz evidently didn't hear. "Because I got enough trouble already with the larger dots we been using. Some days it gets me swatting flies before I'm done with the convergence."

"Look, Fuzz," Red replied in an exasperated tone, "just because the dots are sharp and small, you don't have to stand there all day like an idiot trying to make them perfectly white."

"Tell me what I *am* supposed to do, then," Fuzz demanded.

"Just like we always do," Red explained. "Stop converging when the patttern looks real roger from 4 feet back."

"You don't have to be nuts to be a color TV tech . . ." Fuzz started to say.

"But it sure helps," Bess completed the saying. "You know, Fuzzy, I was only kidding when I tossed that creamer at you yesterday."

"What creamer?" asked Fuzzball.

"He don't even remember," Red advised her.

"How does the new car run?" Bess asked.

"OK, I guess," Fuzz replied. "What's the best kind of pattern generator?"

Red shrugged his shoulders. "There's lots of good pattern generators around. Let's put it this way—there's certain important things to look for when you're getting a generator."

"Such as?"

Pattern must be stable

"First of all, the pattern has got to be *stable*. It's hard enough to converge a picture tube without having the dots jumping around."

Fuzzball rose and bowed to the east three times. "Amen," he said.

"Peace," Red grinned.

"Then, the output has got to be *linear*," Red added.

"You mean to say some pattern generators have a nonlinear signal?"

"The answer, I am sorry to say, is yes," Red replied. "Look at this here pattern (Fig. 1)."

"You mean to say the generator's doing that?" Fuzzball asked incredulously. "In other words, I would misadjust the vertical linearity, and go away thataway."

"Not only that," Red replied, "linearity affects convergence. If you try to straighten up the linearity later, the vertical convergence will be thrown out."

"I would have the set foxed up until Hades won't have it," Fuzz said.

"That's the general idea."

"Something ought to be done," Fuzzball said firmly.

"The only thing to do is to pay enough to get a good generator," Red replied.

"And another thing," Fuzz observed, "there's horizontal pulling at the top of the pattern. Was that the generator too?"

"Man, you're sharp as a wet noodle today. You're using both heads."

"You're a comedian," Fuzz replied sourly. "Was it actually the generator?"

"Yes," Red advised. "It is caused by nonstandard sync."

"Translation, please," Fuzz asked.

"Well," Red explained, "some low-priced generators have a sync pulse that is wider than a true pulse, but narrower than a blanking pedestal. The receiver doesn't lock on it real good like."

"Maybe you better draw a diagram," Fuzz protested.

"Well, the deal is this," Red explained, "the width of a sync pulse is right for operating a lot of horizontal sync circuits that we find in recent sets. But when you widen that sync pulse out, the sync circuit begins to act up."

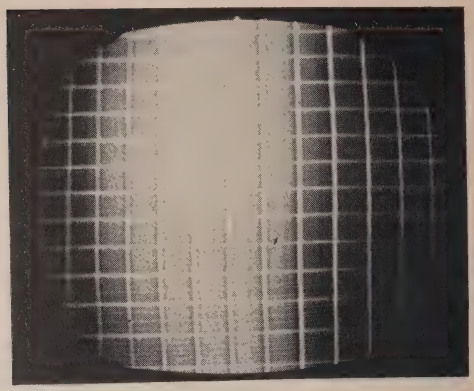
"So why is it widened out?" Fuzz asked with a puzzled look.

"Economy," Red replied; "we want to get horizontal sync. We also want to get horizontal blanking. To save money we want to do both with a simple pulse."

"Now I'm beginning to catch," Fuzz announced. "The pulse is widened out just enough to blank the retrace, hoping that it will still work as a sync pulse."

Fig. 2—The retrace wasn't entirely blanked and the pattern was pincushioned.

Fig. 3—Rainbow and crosshatch can be shown together on the picture tube.



"Smart, smart," Red drawled. "Now then take a look at this one (Fig. 2)."

"The retrace ain't entirely blanked out," Fuzz observed.

"Right. Some of these color sets have a long retrace time. Unless the blanking pulse is standard width, part of the retrace may be unblanked."

"And another thing," Fuzz spoke up.

"What?"

"Look at the pincushion. Is that the generator too?"

"No," Red replied, "that's the picture tube. It's something that you'll see only on the small-screen color tubes."

"Not many of them around," Fuzz remarked.

"No," Red agreed. "But once in a blue moon we get a call from one of our valued customers who still has one of these old sets in the kid's room or somewhere."

"I'm beginning to get hep to this color TV racket," Fuzz observed proudly.

"Don't pat yourself on the back too hard," Red advised, "you might break your arm."

"His head ain't even screwed on straight," Bess said acidly.

Fuzzball scowled at her and didn't reply. Red grinned.

"No kidding, Red," Fuzzball continued, "do you figure I could hit old Fatpants for a raise?"

"I would think it over very carefully," Red suggested.

"But the wheel that squeaks the most gets the grease," Fuzzball observed.

"Yes, and after the wheel gets greased several times and still squeaks, it gets replaced," Red explained. "You're a good kid, but not indispensable."

"Old Fatpants wouldn't dare," Fuzzball protested.

"Wanna bet?" Red asked.

"Not to change the subject," Fuzz replied, "but do you figure that small dots or large dots are better?"

"Depends a lot on conditions," Red explained. "If you're working from the back of the set and looking in a mirror, you need big dots. Can't see the little ones for sour apples."

"I hear they got some generators with adjustable dot size," Fuzzball recalled.

"Right. Some have a switch for two dot sizes. Some have a control for varying the dot size over quite a range."

Dots or crosshatch

"There's another kind of pattern generator too," Fuzz recalled. "It gives you either white dots or crosshatch."

"Several of them do that," Red agreed. "When you can use crosshatch, it takes the place of big dots. You can see crosshatch a lot better from in back of a set than you can them little dots."

"What other kinds of pattern generators are there?" Fuzz asked.

"Well, there's the kind that has white dot, crosshatch and rainbow," Red explained.

"That would be a real good deal for installation," Fuzz observed. "Saves you carrying more than one instrument up and down stairs."

"You can run the rainbow and crosshatch together, too," Red pointed out (Fig. 3).

"Why would you do a thing like that?" Fuzzball demanded.

"That's in bench work," Red replied. "It marks the rainbow for checking phase in the chroma circuits."

"How would that work?" Fuzz asked.

"Well, each 30° is a basic chroma axis. But we'll go into that another time.

"I reckon as how," Fuzzball suggested, "these generators you're talking about now have modulated rf output."

"Yes. But they also have video output too," Red explained.

"You mean you can drive the picture tube directly?"

"No, not that. The video output is about 1 or 2 volts. Just enough to drive at the output of the picture detector."

"What's the idea?"

"Takes us to bench work again. If you inject a video signal at the picture detector, you split the receiver circuits into two parts."

"I catch," said Fuzz. "If you got a no-color complaint, you can slap the signal in at the detector and see if you get color there."

"You're a brain," Red remarked.

Fuzzball glanced up automatically at Bess. She hadn't heard the remark.

"I still figure old Fatpants ought to give me a raise," Fuzzball mused.

"Take my advice and forget it," Red advised.

"Say, I ran into a new one yesterday," Fuzz announced.

"So? What was that?"

"It was that Sylvania. Didn't have the usual high-voltage interlock."

"What did you do?" Red asked.

"Well, I fumbled around a while," Fuzz admitted.

"Then you maybe found the shorting lever on the back of the high-voltage cage?" Red asked.

Fuzz looked at him in amazement. "You know about it?"

"Fuzz, wake up," Red grinned. "Remember I told you about that more than three, four months back."

"Must have forgot," Fuzz said, unbelieving.

"Sure. Look, I even got a picture of the gismo here in my notebook (Fig. 4)."

"Yop, that's it," Fuzzball agreed. "You press down the lever and hook the trigger wire over it."

"What would you do without me?" Red asked teasingly.

Fuzzball made a wry face. "I may not be smart, but I'm hep," he remarked.

"You said that before," Bess accused him. "How about turning the record over for a change?"

Fuzz started to open his mouth, and then coughed violently as Red blew a cloud of smoke into his face.

Fuzzball recovered and wiped the tears from his eyes. "I don't know why I put up with you sometimes," he said bitterly.

"Nobody asked you to," Red observed.

"OK, OK," said Fuzz. "But to get back, how many channels can you tune on the different pattern generators?"

"Depends," Red replied. "Some have a six-position switch to hit the low channels."

"That would be important sometimes," Fuzz observed.

"Very important," Red agreed. "Any

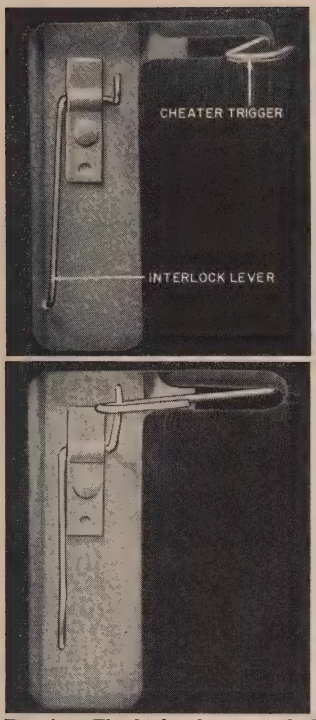


Fig. 4-a—The high-voltage interlock in its normal position; b—interlock lever sprung down and held by trigger wire.

time you pick up interference in your dot or crosshatch pattern, you have had it. The pattern doesn't lock worth a tinker's dang."

"What other kinds they got?" Fuzz asked.

"Well, others are continuously tunable over the low channels," Red explained.

"But none cover the high channels," Fuzz hazarded.

"They all do," Red corrected him. "They all work the high channels on harmonics."

"Is that OK?" asked Fuzz.

"It works," Red replied. "But how often do you need to go to the high channels anyhow?"

"Once in a coon's age maybe," Fuzzball agreed.

"There are a few pattern generators that have output on only one channel," Red concluded.

"Is that good or bad?" Fuzz asked.

"It ain't bad, really," Red observed. "If you run into interference, there's a service adjustment for tuning the output over into another channel. Once you set it for your own area, that's all that's necessary."

"A color tech really has to hustle," Fuzzball said, shaking his head.

"He has to fish or cut bait," Red agreed.

"I like that new car you got," Bess remarked to Fuzzball. "How does it ride?"

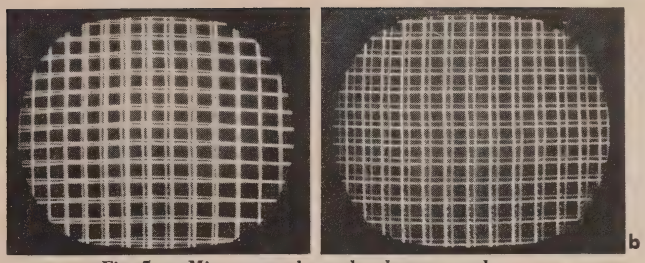


Fig. 5-a—Misconverged crosshatch pattern, three beams; b—misconverged pattern, two beams.

"Pretty good, I guess," Fuzzball replied casually.

"Now here," said Red reaching into his inside pocket, "is the way a misconverged crosshatch pattern looks with three beams on, and with two beams on (Fig. 5)."

"I recollect some techs cut off the blue beam to start," Fuzz remarked. "It's often less confusing to get the parallel lineups with only two guns on."

"Do you know how to turn guns on and off the easy way?" Red asked.

"Don't reckon I do," Fuzzball admitted.

"Let me clue you in. You can get a switch box to plug on the base of the picture tube."

"There's a deal," Fuzz said enthusiastically.

"Saves a lot of horsing around," Red agreed. "The switch has positions for red, green or blue output. Gives you all three guns together if you want. You can also switch a meter or scope on to any grid or to the cathodes of the picture tube."

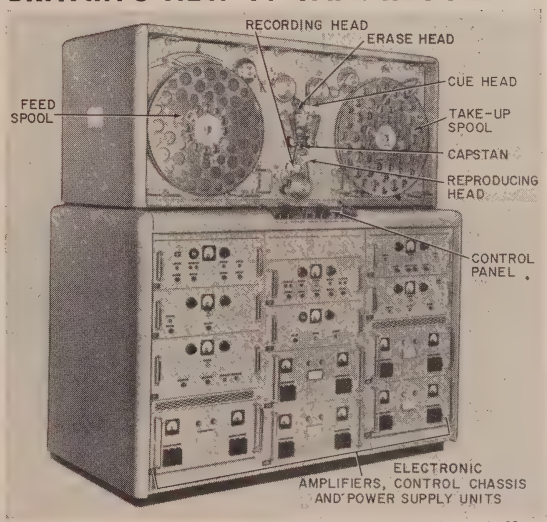
"That's for me," Fuzzball said brightly.

Bess leaned her elbows on the counter. "I guess I got to walk home again after dark by myself," she remarked.

"You're safe," Fuzzball reassured her.

"Never did see a man go through a door so fast," Red informed Bess a moment later. END

BRITAIN'S NEW TV TAPE RECORDER



Courtesy BBC and Electronic News

A new TV tape recorder, third to be announced within 2 years, has been developed by the British Broadcasting Corp. (BBC). Unlike the Ampex and RCA machines with their 2-inch-wide tape and revolving record–playback heads, BBC's VERA (*V*ision *E*lectronics *R*ecording *A*pparatus) uses standard ½-inch magnetic tape, and has separate record and playback heads so tape may be monitored as it is recorded. Tape speed is 200 inches per second, as opposed to 15 inches on American models, and a 24-inch reel of tape is required for 15 minutes of recording. Picture information is recorded on two longitudinal tracks—0–100 kc on one and 100 kc–3 mc on the other. A third track records audio. BBC has ordered two Ampex Videotape recorders and plans to test them side-by-side in the field.

tv dx

By ROBERT B. COOPER, JR.

WITH the sunspot count on its waning side, overall effects of the now-famous 11-year cycle are being studied, with particular interest in vhf propagation.

In past years, reports which told of extraordinary long-range reception were often regarded as cases of mistaken identity or perhaps even a deliberate hoax. However, during the past 12 months, we have developed a sixth sense which makes us look twice at such dx loggings. After all, dxing the TV frequencies has been largely a case of exploring the unknown and uncovering new items of information, bit by bit, until we have an end result which indicates a new form of dxing and another mode by which the alert TV dx fan can drag in those faraway television stations.

March, 1958, was a slow month dx-wise for the greatest majority of TV dx fans across the country. One very unusual occurrence was a full-scale Sporadic E skip break, on March 15, which brought a 6-hour Es session to just about every section of the country west of the Mississippi. Signals were strong with much co-channel interference as high as channel 6. At the height of the opening, Ron Pugh of Ft. Bragg, Calif., switched to channel 7 to find KLZ-TV, Denver, Colo., showing with fast-fading audio and video. Reception was short lived, however, running from 1820–1832 PST. The distance involved is nearly 950 miles and the event represents one more instance of high-band signal propagation over a Sporadic-E skip distance during a widespread Es opening on the lower channels.

Another totally unexplained series of loggings is reported by Ray F. Boyd, Zirconia, N. C., when on the night of March 14 he logged seven California stations, including KCOP, channel 13, and KABC-TV, channel 7, both Los Angeles. These reports, if accurate, involve distances of nearly 2,500 miles on the high-band channels and come very close to providing a set of distances that may not be approached in the near future by TV dx enthusiasts.

FM and TV dx

Although you may not be completely aware of it, your television dx reports serve a very valuable scientific purpose. After RADIO-ELECTRONICS finishes with the compilation, the reports are filed away for later study by prominent groups of scientists. Such reports are of definite scientific interest, as they illustrate freaks of nature and are therefore subject to further explanation by properly qualified authorities.

However, these reports do not serve as an end, but merely as a means toward an end. To understand completely the actions of vhf–uhf signals in our atmosphere, stratosphere and ionosphere, we should study not only the piecemeal samples of the spectrum (such as TV provides). We must also make use of every faculty available to us, including every type of unusual dx report which falls within the vhf–uhf region.

This is where the Frequency Modulation (FM) band enters the picture. FM helps fill a frequency range which lays between channels 6 and 7. Many other services such as taxi, police, airport and amateur have room within this range, but only FM is commercially available to the public. We have good reason to believe that the FM band's dx actions will resemble to some extent those of television channel 6, but we cannot be sure. To help fill in our knowledge holes, we are instituting an FM dx section, to be run at the beginning as a sidecar of the Television Dx Column.

Some major differences between the two, however, will be immediately self-evident. As FM dxing is not an organized hobby on a national scale, we will find it necessary to set our own limits as to what constitutes dx via FM and expand these guide posts as the hobby develops. We also wish to carry an occasional paragraph on antennas, tuners and the like, purely from a sensitivity standpoint. It is hoped that both the hobby and column will grow together. To get the ball rolling, FM dx reports, lists of stations received, and so on are needed to begin our book of standards. Send along your results for listing.

Predictions: July–August, 1958

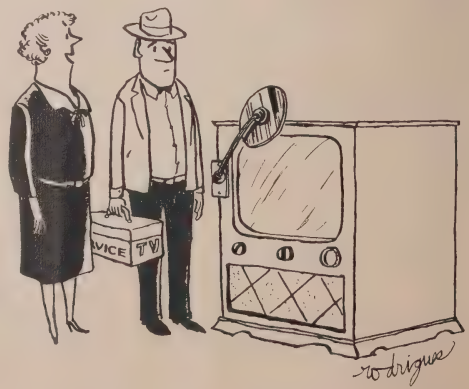
The first and last weeks of July normally produce a good deal of Sporadic-E reception, with many sessions running as high as the lower FM channels. The best hours of the day continue to be 0700–1000, 1200–1400 and 1700–2000, all local standard time. By August, E sessions will begin to dwindle toward the normal fall low point, with any sessions after Aug. 15 running from 1600–2100 local standard time. E skip may hold up weakly as late as early September in southern latitudes along the Gulf Coast. One period expected to be especially hot for Es is July 25–28.

The summer months, with their slow-moving frontal systems and evening temperature inversions, is always ideal for extending the normal ground-wave range. Just after sunup and from sundown until midnight are periods usually especially productive over coastal, Gulf Coast and Great Lakes paths. Early evening and on until early morning hours will bring the best high-band ground-wave reception across the Great Plain States. Again, keep tabs on your fringe-area stations and watch for signs of general improvement in fringe-area signals.

The one major meteor shower of the year is due to become apparent in the early morning hours of Aug. 5–15. The Perseids shower is an annual occurrence, bringing joy to the heart of meteor-burst enthusiasts all over the country. Bursts on the high-band TV channels (7-13) are especially profitable during this period, peaking from the 12th–14th. Careful planning and the checking of operating schedules of stations 800–1,400 miles distant on channels 7–13 may result in some excellent loggings on your part, which you are not likely to intercept by any other form of wave propagation.

Report forms

Reporters to the TV Dx Column are urged to drop a postcard to the TV Dx Column, RADIO-ELECTRONICS Magazine, 154 W. 14 St., New York 11, N.Y. In return we mail you a set of prepared dxing forms. These are engineered to extract all necessary information from you the dxer and make dx reporting as painless as possible. Oh yes, they also function on the FM band . . . send for yours today . . . they're free! END



"We've had so much trouble with this set that my husband installed that permanent mirror!"

TV Service CLINIC

conducted by

ROBERT G. MIDDLETON
TELEVISION CONSULTANT

ABSORPTION markers are extensively used in color TV service. An absorption marker output, compared with that of a beat marker, is shown in Fig. 1. An absorption marker produces a dip in the response curve, instead of a "bug."

Absorption markers are used in video-frequency test work because they have no harmonics. Hence, spurious markers, which may confuse the technician, do not occur.

Chroma circuits are commonly aligned using an absorption marker-box such as the RCA WG-295B in series with the output cable from the sweep generator. The WG-295B marker box provides spot-check frequencies, commonly at 0.5, 1.5, 2.5, 3.0, 3.58, 4.1 and 4.5 mc, as shown in Fig. 2. This is how the markers appear on a demodulated signal.

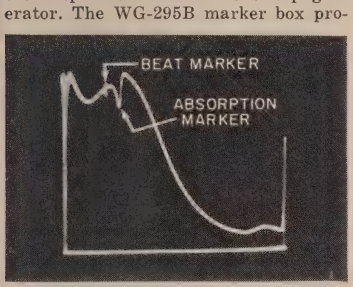


Fig. 1—Absorption and beat marker on video-frequency response curve.

Undemodulated signals are also commonly used in chroma circuit testing. Then the same markers appear as shown in Fig. 3.

It is necessary to identify these various spot-check frequencies. Hence, terminals are brought out to the side of the marker box for each marker frequency. If the technician touches a finger to one of the terminals, he detunes the respective marker coil in the box. This causes the marker to move on the curve, and identifies it.

Drifting horizontal hold

On a Motorola TS-60 the horizontal hold control has to be reset as the receiver warms up. The trouble started after the germanium rectifiers were replaced with silicon rectifiers. I have replaced numerous parts in the horizontal oscillator circuit. What do you suggest as a cure?—R. L. W., St. Louis, Mo.

Silicon rectifiers have a lower internal resistance than germanium rectifiers. This raises the B-plus voltage. To obtain original supply voltages, insert series resistors with the silicon rectifiers. The required values may be found by trial.

Shrinking picture

The picture on a Philco 24C6010 shrinks after operating for about an hour. I checked all components in the vertical section. Can you give me some help?—R. W. G., Silver Spring, Md.

The clue to the trouble is that the picture shrinks after the set has warmed up completely. It is most likely thermal trouble. Use a heat lamp, and you will doubtlessly be able to make the picture shrink rapidly from a cold start. To localize the heat to one component at a time, use a cardboard mask with a 1-inch cutout in front of the lamp.

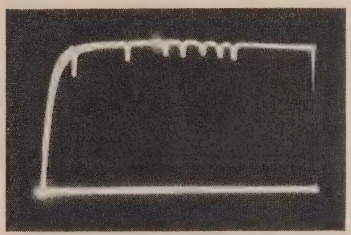


Fig. 2—Series of absorption markers from video-frequency marker box.

Snow on one channel

A Westinghouse H-784K21 operates OK on channels 3 and 8, but has trouble on 13, which is very snowy. Voltages check correctly. The sound is also bad on 13.—O. R. W., Ashland, Ky.

Although voltages measure OK, you will undoubtedly find the trouble in the channel 13 section of the tuner. Look for poor contacts. A coil may be defective, but this is less likely.

110° conversion

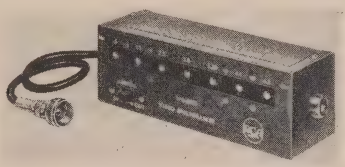
A customer wants me to install a 110° picture tube in a Tech-Master 2430N. What changes will be required? —E. J. S., High Falls Park, N. Y.

The conversion is practical, but will work a single 6CD6 to the limit. Paralleling two 6CD6's would be possible, but would waste power, drawing from 125 to 150 ma. It would be best to parallel two 6BQ6's, which will reduce the drain to 90–100 ma. The damper should be changed from a 6W4 to 6V3. Of course, a suitable yoke, flyback, and vertical output transformer will have to be used.

Using a Neutrode tuner

Can a Neutrode tuner be used in a G-E 17C125 receiver?—D. M. B., Bluefield, W. Va.

This is principally a mechanical problem. This chassis has a 41-mc if strip, so you should be sure to use a tuner with this if output frequency. Also, use a tuner with 6.3-volt tubes. The present supply voltages in the 17C125 will be suitable for the tuner. When the tuner is installed, be sure to make a complete alignment with a good sweep and marker generator, to get the full benefit of the conversion.



The RCA WG-295B Video MultiMarker.

Green on the screen

Most of the color TV sets here have a greenish hue during black-and-white reception. If there is any answer to this annoying "gang-green," we in Harrisburg will be most grateful.—I. F. B., Harrisburg, Pa.

There are several possible causes of this complaint:

1. A raster which is balanced for one condition of room lighting will be unbalanced with other types of room lighting. It is quite possible to have a neutral gray raster in the afternoon, and a green or blue raster in the evening. Rasters must be balanced for the lighting condition used during black-and-white reception.

2. If the color killer is not set up

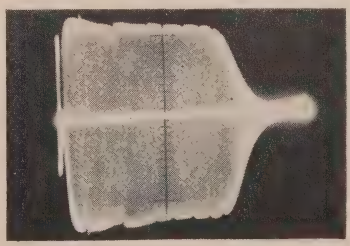


Fig. 3—A series of absorption markers on an undemodulated video-frequency sweep signal.

far enough, interference and noise get into the chroma channels during black-and-white reception. This causes a bluish-green tint.

3. Any misconvergence will cause color fringing. Green fringing is most objectionable during black-and-white reception.

4. Poor tracking of the picture tube or overdrive in highlights past the limits of tracking can also cause greenish areas to apear in a black-and-white picture.

5. It is good practice to balance the background and screen controls, not for a perfectly neutral gray raster, but for a slightly brown raster. Do not put in enough red to make the customer complain, but as much as he will go for. The end result is much more satisfactory.

Signal radiation

A Packard-Bell 2692 receiver radiates interference to other sets in a duplex. Operation of the Packard-Bell on channel 9 interferes with other reception on channel 13. Can this interference be trapped out, or must the oscillator frequency be changed?—J. J. K., Tucson, Ariz.

Disconnect the lead-in from the receiver and see if the interference to other receivers stops. This will almost certainly be the case, unless the power cord is carrying rf to the power lines. The interference can be trapped. Insert a 212-mc trap in each lead to the antenna coil for channel 9, inside the turret. The traps are very small and easily contained in the turret.

Circuit ghosts

I installed two Standard Coil tuners in RCA 630-TS chassis, but have a very noticeable ghost. The edges of dark objects are outlined with white lines. The pentode tuner gave less ghost effect. What is causing this trouble?—H. E. A., Romulus, Mich.

These are circuit ghosts. They are caused by high video peaking (poor alignment). After installing a new tuner, use a good sweep and marker generator to obtain flat response from the rf and if amplifiers. Also, sweep the video amplifier and adjust the peaking coils and load resistors, if necessary, to obtain a flat video response. The ghosts will then disappear.

TV causes whistle

A 17-inch Air King TV receiver causes particularly bad whistling interference in a radio in the same house. All shields are in place, in both the TV and the radio. The same whistle also appears in any radio brought into the house.—C. H. B., Newtown Square, Pa.

This whistling sound is undoubtedly due to the harmonics of the flyback system, which are being picked up by the radio. If you tune the dial of the radio slowly, you will probably note that the whistle is tunable. A beat will be found at intervals of 15,750 cycles. The harmonics are very possibly being conducted by the power line, and an rf filter between the power cord and the receiver chassis will clear up the trouble. A good outside antenna for the radio will also help, as the radio's agc voltage will then be increased. Sometimes the harmonics are radiated by exposed flyback leads and shielding becomes necessary. In some cases the whole interior of the cabinet must be lined with metal foil or copper screen. Even the face of the picture tube may radiate a small harmonic field. This is a source which cannot be readily controlled.

Which yoke and flyback

One of our customers wants his G-E 24C101 that uses a 24AP4 picture tube converted for a glass 27RP4 or a 27NP4. Can you give me any information concerning what yoke and flyback transformer to use, and how the connections are made?—P. J. H., Seattle, Wash.

A new yoke and flyback transformer will be required to convert the receiver to either 27RP4 or the 27NP4. The 27-inch tubes all have 90° deflection and require a minimum of 18,000 volts. The 24-inch tube operates with 12,000–16,000 volts. The 27RP4 poses the fewest difficulties. You will find useful data packed with the RCA flyback and yoke for conversion to 27-inch tubes. These RCA components are a good choice for this conversion.

Callback difficulty

I would appreciate your help on a Trav-Ler model 16G50A. I replaced the output transformer and a burnt resistor R108. The set worked OK in the shop, but after delivery to the customer the resistor burned out again. There was also a very loud high-pitched whistle. What could cause this trouble? —A. L., New York

This difficulty has a familiar ring. I have seen several such cases in which marginal electrolytic capacitors in the horizontal sweep and oscillator sections were responsible. The capacitors become poorer as receiver operation is continued, and eventually a breakdown occurs. The basic trouble is a feedback condition. That is, faulty electrolytics permit coupling of the sweep and oscillator sections, and also coupling to other receiver sections. This results in an oscillation or squegging, which causes the high-pitched whistle that you note. Make a thorough check of the electrolytics in the horizontal section, and replace any that are below par in capacitance value or power factor.

Defective color tubes

In 16 months I have had two 19VP22 picture tubes go bad due to shorts and arcing in the guns (CBS 205 color TV receiver).—R. F. P., Toledo, Ohio

It would appear that there is an operating fault present which causes the picture tubes to arc in the neck and fail. I have personally had very good experience with the 19VP22 in three receivers and feel that it is a well-made tube.

I have also seen color picture tubes go bad because they were operated at excessively high beam current which overheats the shadow mask and can gas the tube, finally causing arcing and tube failure.

It would be advisable to check the beam current (particularly the red screen current) which is being drawn by the tube with the controls set in usual operating positions. Make sure that you are not exceeding the limits specified by the manufacturer. The red screen is controlled by R8, and the high-voltage value is controlled by R28. The total beam current is also determined by the setting of the brightness control R4.

17-inch conversion

I have an Automatic TV receiver, model 707, with a 7JP4 picture tube. I would like to convert this chassis for use with a 12- or 17-inch picture tube. —R. W., East Orange, N. J.

This conversion is not very practical. The receiver has an rf power supply which provides only 5,000 volts. The 7JP4 picture tube uses electrostatic deflection, and the receiver does not provide horizontal afc.

A larger picture tube will require a complete rebuilding of the horizontal sweep and high-voltage system, and you are not likely to be very content with the stability of horizontal sync on a large screen without horizontal afc. Hence, a complete conversion would also require putting in additional sync tubes and circuits.

The considerably larger current demand of the converted receiver will raise the hum level, drop the B-plus voltage and overheat the power supply and filter.

Our recommendation is to try to utilize this receiver in some manner without conversion. Perhaps you can use it as a second receiver if you do not wish to trade it in on a large-screen set.

END

"Does that answer your question regarding the high-voltage section?"

Improving the SMALL ALL-WAVE RADIO

Some simple modifications that will boost the performance of an inexpensive all-wave receiver

By HECTOR E. FRENCH, W1JKZ

MOST amateurs and SWL's have seen or used one of the many inexpensive all-wave receivers now on the market. All these sets give good results, whether the buyer wants a radio for the kitchen, a set for listening to shortwave broadcasts or a receiver for phone or CW amateur station operation. But even though these little sets do a wonderfully effective job, there's only so much the design engineer can do with a limited number of tubes, a small cabinet and a low selling price. This leaves you the opportunity to improve the receiver yourself by making a few simple, inexpensive modifications.

Fig. 1 shows how a simple audio system responds to a pulse input. This

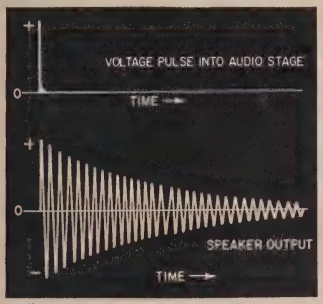


Fig. 1—Waveforms showing how a minimum-design audio channel may respond to an audio pulse.

pulse can be a "click" as from automobile ignition noise, or it can be a "thump" as a bass drum or the lower-toned syllables of male speech. The difficulty is that instead of going through as just a click or a thump, the audio-amplifier–speaker–cabinet combination reproduces this pulse as a long train of damped oscillations. This makes the click or thump sound much louder than it really is.

The click is reproduced as high-pitched damped oscillation of different parts of the speaker cone. The thump is reproduced as a back-and-forth motion of the entire speaker cone. These oscillations are only slightly damped (by the amplifier, the speaker and the air), so they can go on for as long as 20 or 30 cycles before they die out.

This phenomenon is known as ringing or (especially in the low frequencies) hangover. The high-frequency ringing changes the normally smooth, silky background hiss of a receiver to a harsh, high-pitched roaring sound, which unfortunately doesn't always stay in the background. The low-frequency

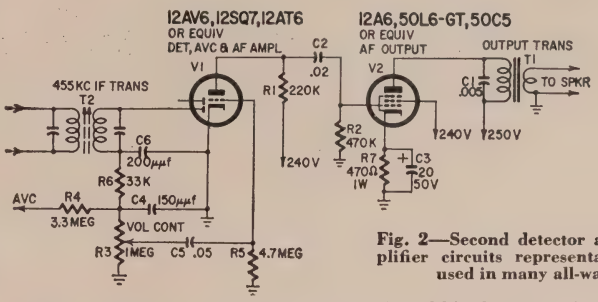


Fig. 2—Second detector and audio amplifier circuits representative of those used in many all-wave sets.

ringing or hangover accentuates low-frequency rumble, noise and hum. All this emphasis of undesired noise hurts the signal-to-noise ratio of the receiver and makes the reproduction less pleasant and natural. The question is what can we do about it?

Into the audio circuit

The damped waveform goes on for a number of cycles until the energy in the click or thump has been dissipated. What is needed is a way to use up this energy fast, reducing the length of time this damped wave will last. There are a number of ways to do this.

Fig. 2 shows a simple diode detector and two-stage amplifier representative of the circuit used in most of these small receivers. The grid of audio tube V1 is self-biased through a high-value grid leak. The output tube (V2) uses conventional cathode biasing and a straightforward plate circuit having a small output transformer feeding the speaker voice coil. Capacitor C1 across the output transformer helps eliminate higher-pitched noise components without affecting intelligibility.

One problem which makes ringing worse is inherent in the circuit. The output tube has a high plate resistance. This high plate resistance does not help damp out any oscillations in the speaker caused by a click or thump.

Fig. 3 shows one way to improve the situation. This is a very simple modification. Simply take the B-plus end of R1 (7/1's plate-load resistor), disconnect it from the B-plus supply and connect it to the plate of the output tube. What you've done is to put a negative feedback loop around V2—from the plate of V2 through R1 and C2, back to the grid of V2 again. This has the advantages of not only reducing distortion, but also of reducing V2's plate impedance to the point where the output tube will help damp these spurious speaker oscillations. This change won't damp the oscillations completely—that's too much to expect—but it will give an immediate improvement.

Then, if you wish, you can *increase* the size of C1 until the high-frequency response just starts to fall off, and *decrease* the size of C2 until the bass frequency response just starts to droop. This will give you the ideal bandwidth for your audio section, with a moderately sharp drop in response outside this range.

This method is very easy, but it does bring up one problem. It's apt to increase the receiver's hum level, since the B-plus for the output tube is usually not as well filtered as the B-plus for the audio input tube V1. Therefore, you may wish to place a 40-μf 450-volt electrolytic across the B-plus line to V2's plate to reduce any hum to where it can no longer be heard.

Another circuit change

Fig. 4 shows still another way to increase the damping of V2. This circuit requires additional components, but avoids the hum problem which might arise with the change shown in Fig. 3. With this circuit (Fig. 4), the functions of the diode rectifiers in V1 are performed by one or more crystal diodes. To modify the amplifier, replace the diodes in V1 with crystal units, lift V1's cathode from ground, place a cathode-biasing resistor and capacitor in

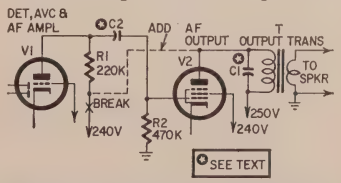


Fig. 3—Modification showing negative voltage feedback from plate of output stage.

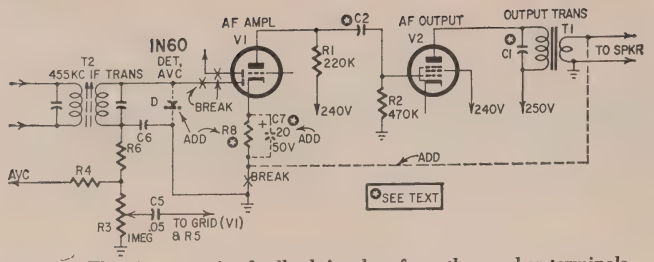


Fig. 4—This time negative feedback is taken from the speaker terminals.

the cathode circuit and return the cathode circuit to the hot side of the output transformer's secondary. If the set breaks into oscillation, interchange connections to either the primary or the secondary of the output transformer.

The value of the cathode resistor ranges from 1–1.5% of the value of plate resistor R1. Just as in Fig. 3, you may *increase* the value of C1 until the high-frequency response just starts to droop and *decrease* the size of C2 until the low-frequency response just starts to fall off. As before, this gives the ideal bandwidth for your audio stages, with a sharp rolloff outside this band.

Some receivers have a noise limiter in the circuit between the plate of V1 and the grid of V2. After making the preceding changes, this limiting circuit should be removed. As originally designed, the limiting circuit helped reduce interference by clipping off any click interference which happened to be higher than the signals. With the modifications shown in Figs. 3 and 4, the click interference is well controlled by the added damping presented by the output tube. In listening tests, the damping not only does a better job than the limiting, but also makes the background noise of the receiver less objectionable and cuts down low-frequency ringing—two things a clipper circuit cannot do.

Each of these modifications reduces the audio gain of your set. What you are doing is giving up audio gain for audio quality. So if you have more audio gain than you need, you can make the modifications shown in Figs. 3 and 4 at the same time. Or if this combined circuit drops your gain below what you'd like, Fig. 5 shows how to use both feedback systems at the same time, by using a resistance voltage-divider circuit which will cut down the feedback voltage in each feedback loop.

Now it's the speaker's turn

This is, however, only half the problem of improving the receiver. After making these modifications, you've probably done as much as can conveniently be done in the electronic end of the audio channel. Now let's see what can be done with the speaker and its mounting.

First, let's take up the high-pitched type of ringing. The length of time this ringing persists (a few milliseconds is enough to cause trouble) and the frequencies at which the ringing occurs depend primarily on the speaker itself, and only partly on the circuit which drives it. At high frequencies the speaker cone breaks up, so while one part of the cone may be moving outward *from* the speaker magnet, another part of the cone may be moving inward *toward* the speaker magnet. This is the kind of thing that gives speaker design engineers gray hair and makes speaker design as much of an art as it is a science.

Note that modifications of Figs. 3 and 4 will help reduce ringing at high frequencies by cutting down the length of time this ringing will continue. However, this works well only when the output tube (V2) is tightly coupled to the speaker coil. Tight coupling requires a lot of magnetic force in the speaker air gap—the average small-set speaker doesn't have enough magnet to do the job properly. For this application you should look for a small, say 6–10 inch, public-address type of PM speaker. Not a wide-range hi-fi unit—the extended frequency range of a hi-fi speaker can actually be a disadvantage in radio communication. Instead, look for a husky speaker with a big heavy magnet.

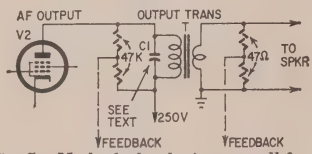


Fig. 5—Method of reducing overall feedback by using a resistance divider.

Small speakers, under 6 inches, do not have large magnets and tend to color the reproduced sound, while speakers larger than 10 inches in diameter are usually expensive and present mounting problems in small apartments.

The speaker you finally select as a replacement must, of course, be mounted in some kind of enclosure. If it fits, it may very well go into the original radio as a replacement. But let's look into the low-frequency considerations, before mounting the speaker.

Low-frequency ringing or hangover is determined by the speaker, the tube which drives it and the speaker enclosure. The type of speaker just recommended for reduction of high-frequency ringing will also be exactly the speaker to use to help reduce the low-frequency ringing. And since we've already modified the receiver so that the output tube is doing its part toward reducing the ringing, that leaves the speaker enclosure as the only remaining variable.

Speaker mountings

Fig. 6 shows a speaker mounted in four ways. Fig. 6-a shows the speaker mounted on a flat baffle board—the simplest method of all.

This is a convenient and simple mounting, but awkward, since a square baffle 24 inches on a side gives a flat response down only to about 500 cycles, with a severe dip near 950 cycles if the speaker is mounted in the middle of the baffle (this dip looks much worse on the response curve than it sounds). Except for the awkward appearance of the baffle, and the difficulty in finding a place to put it, this is a perfectly good method of mounting.

The second method (Fig. 6-b) shows the speaker mounted in an open-back cabinet. Most radio and TV sets use this type of mounting. There is a strong resonant peak at a frequency determined by the speaker and the dimensions of the cabinet. This gives the boom to juke-box bass and in a smaller set (including most of the small all-wave receivers) this peak comes in the middle of the audio range, to increase the apparent audio efficiency. This resonance and the resulting ringing add an unnatural quality to the reproduction, especially to a male voice. While the radio amateur may not be particularly interested in a natural-sounding tone of voice, he is definitely interested in intelligible re-

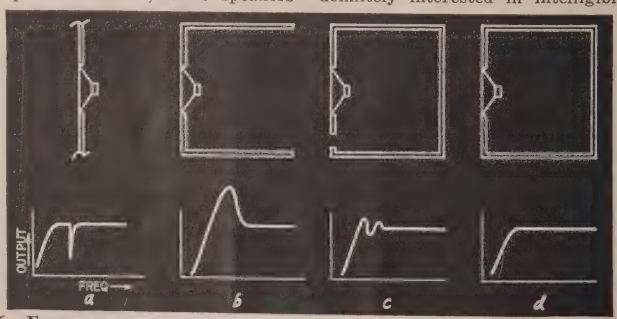
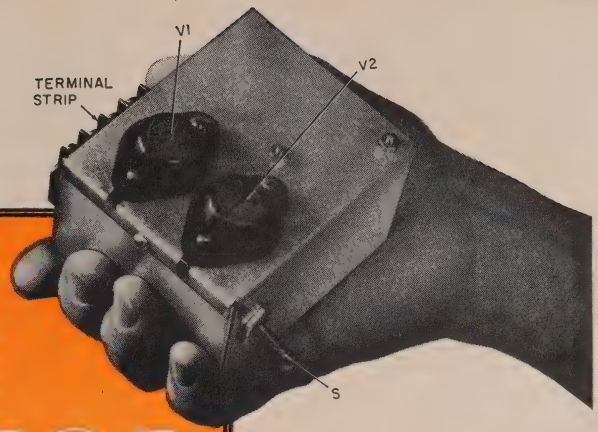


Fig. 6—Frequency response of a speaker mounted in various ways: a—baffle board; b—open-back cabinet; c—vented cabinet; d—closed-back cabinet.

Mobile power supply which provides B-plus for your car transmitter or receiver has no vibrator

By BILL HAMLIN, W1MCA

TRANSISTORS REPLACE THE VIBRATOR



The unit, which nestles in the palm of your hand, has the power transistors mounted on the outside of its case.

HOW would you like to throw away that old vibrator supply and replace it with a modern transistor unit that will operate more efficiently over a long and trouble-free life? The transistor vibrator substitute described here is easy to build and provides all the advantages claimed for this type of power supply.

This is a 30-watt unit approaching the practical limit for automobile type power transistors available at a very low price. Voltage and current output are ideal for small transmitters or large radio receiver B-plus supplies—up to 300 volts at 100 ma. This supply must be powered by a 12-volt battery and uses CBS 2N256 transistors. Current drain is about 2.5–3 amperes. A 150-volt output is available for receiver or screen power.

How it works

Operation of a transistor power supply is easy to understand. The two transistors function very much like the two contacts of a vibrator, switching current first in one direction and then the other through a transformer primary. The transformer steps up the alternating current to the desired value which is rectified and filtered in the conventional manner.

Thus, it is obvious that the transistors do not themselves supply power but are merely current switches. If they had zero resistance, unlimited power could be handled. However, this is not so. There is resistance in the transistors, generating heat which must be kept lower than maximum allowable junction temperature to keep from ruining the transistors.

To get the maximum amount of power the circuit must have the highest possible efficiency. With a good transformer and proper transistor-to-transformer matching, efficiencies of 75% to 85% are usual. For 30 watts input from a 12-volt automobile battery an output of 22.5 watts dc may be obtained from the transistor supply as compared to 45 watts input for 22.5 watts output from an ordinary dynamotor.

The transistor switching action is automatic in a multivibrator circuit. When one transistor is *on*, the other is *off*. The *on* and *off* conditions alternate at the circuit's natural frequency of oscillation. Frequency of oscillation is determined mainly by transformer design and input voltage. The secret of an efficient switching circuit is to have a rapid current rise to transformer saturation, then a sharp current fall, forming a square wave. This is why special transformers are necessary to give a good square wave without excessive core loss.

Thus, we find that the few transformers now being made specifically for transistor power supplies have either

IMPROVING THE SMALL ALL-WAVE RADIO (Continued)

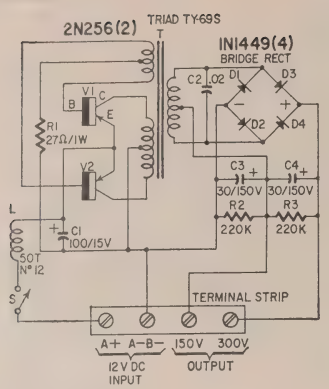
production, and this resonant peak and unnatural sound quality will cut down intelligibility, especially under borderline signal-to-noise conditions.

The third drawing (Fig. 6-c) shows the speaker mounted in a vented, closed-back cabinet. The response curve here has two small peaks rather than one big one. This is an excellent mounting. The only problem is that the vent opening in the cabinet must be acoustically tuned to match the acoustic properties of the speaker and enclosure. If the vent is not tuned properly, speaker response is apt to be as irregular as that of an open-back cabinet or worse.

The fourth drawing (Fig. 6-d) shows what is probably the best solution for this application. Mount the speaker in a box with a closed back. The air inside the cabinet acts like a spring, raising the speaker's resonant frequency somewhat, but without the resonant peak problems of open-back or vented cabinets. For best results, an internal volume of 1–4 cubic feet is suggested.

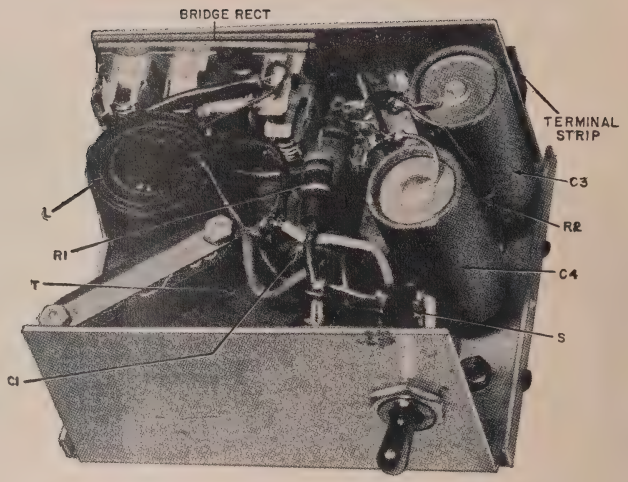
This is not a hard and fast limit; almost any solidly built closed-back cabinet can be made to work well. If the volume is too small, say below 1 cubic foot, the enclosure starts to take over from the speaker and moves the response curve over to the right. A volume of more than about 4 cubic feet has very little advantage over a smaller one and takes up room that can be used for something else. An enclosure this size will not have much effect in determining the frequency response limits. The frequency response will be flat down to a little bit above the natural resonant frequency of the speaker in free air. Regardless of size, the enclosure must be solidly built.

After making these modifications, you should be ready to test the receiver. You will find that the strong stations, such as those on the regular broadcast band, will sound clearer, with a cleaner tone. Weak signals which would have been down in the mud before modification will come through with less straining on your part to identify the station. And both phone and CW signals will be easier to copy through interference. This improvement is due to reduced ringing, smoother frequency response of the audio system and the reduction in harmonic distortion contributed by the improved audio system. This is not intended as a hi-fi modification. Instead it is designed for greater intelligibility under difficult conditions. END



R1—27 ohms, 1 watt
R2, 3—220,000 ohms, ½ watt
C1—100 μf, 15 volts, electrolytic
C2—.02 μf, 1,600 volts
C3, 4—30 μf, 150 volts, electrolytics
D1, 2, 3, 4—bridge rectifier, IN1449 silicon diodes (4) (Audio Devices A16)
L—50 turns No. 12 insulated wire, ½-inch-diameter air core
S—spst toggle
T—power transformer for transistor power supplies: 12-volt input; 300 volts out of rectifier, 100 ma (Triad TY-69S or equivalent)
V1, V2—2N256 (CBS)
Case, 3¾ x 3 x 2⅛ inches
Transistor mounting kit, Bendix No. 210 6500 or thin mica strip (see text)
Miscellaneous hardware

Fig. 1—Circuit of a 30-watt transistor power supply. A 12-volt input gives you a 300-volt output.



Follow this parts layout to get a neat, compact power supply.

toroidal or powdered-iron cores because these types have the highest efficiency, especially at higher frequencies of oscillation. The transformer used in the supply described in this article, a Triad TY-69S, has a powdered-iron core with high efficiency at an oscillation frequency of 2,000 cycles. Regular laminated-steel transformer cores are efficient only at much lower frequencies.

Circuit and construction kinks

The circuit of the transistor power supply is shown in Fig. 1. It uses two inexpensive CBS 2N256 transistors, a special Triad transformer and an Audio Devices full-wave silicon-diode bridge rectifier (A16 using four 1N1449 diodes).

Other power transistors such as the 2N155 or 2N176 can also be used. Their power dissipation rating should equal at least 8.5 watts with heat sink. R1 and C2 have a lot to do with the maximum power output. Lower values of R1 increase power output with its minimum value determined by the transistor's ratings. The value of R1 given in Fig. 1 is for the 2N256 or 2N155 transistors having a power gain of 25 db, but transistors with higher power gains require higher values of R1 because higher gain accompanies less transistor base current.

Capacitor C2 is the buffer, similar to the buffer in vibrator supplies. It eliminates high-voltage spikes that are dangerous to the transistors and diode rectifiers. C2 actually resonates with the transformer. If it is just right, it will boost output slightly and at the same time smooth out the transient spike on the rising square wave. Large values of C2 will smooth better but will lower the frequency of oscillation and reduce output voltage. If a smoother dc output is the object rather than maximum power, a 500- to 1,000-ohm resistor in series with C2 will improve it. However, if the circuit is altered from that shown, because of particular applications or different components available, the right buffer will have to be determined experimentally.

A bridge rectifier is used because it gives the highest voltage output and has the lowest reverse voltage on the diodes as compared to other rectifier circuits. Silicon-diode rectifiers are the most compact and, because of their low voltage drop, give the highest voltage output. The Audio Devices rectifier bridge A16 comes in a complete package with all mounting hardware. This line of silicon rectifiers is being offered as replacements in TV sets and are readily available.

This 300-volt supply is close to the limit for the peak reverse voltage that may be applied to these particular silicon diodes. Higher voltages or doubler circuits, etc. can use inexpensive diodes if two or more are placed in series to divide the reverse voltage across them.

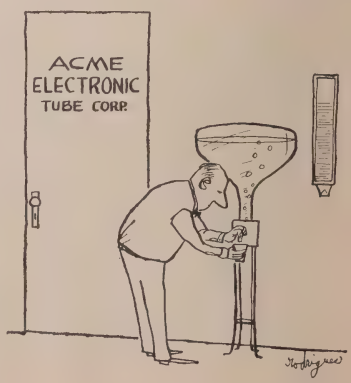
If pulses developed by the oscillating transistors get beyond the supply, interference may be set up in other equipment. This interference is eliminated by L and C1. Coil L is taken from a discarded automobile radio or can be made by winding about 50 turns of No. 12 insulated wire into a cylinder and cementing the turns together.

The transistor supply is built into a 3¾ by 3 by 2⅛-inch box (LMB 135). This appears to be an ideal size and shape for the components. The metal box acts as a heat radiator for the transistors, so if the box is later fastened to metal the transistors will run cooler.

The power transistors have collector and case connected together for better heat transfer. However, the collectors must be insulated from the chassis. This is done with the Bendix automobile transistor mounting kit No. 210 6500 or a thin slice of mica cut to fit can be placed between transistor and chassis. Be sure to insulate the mounting screws with the insulated bushings supplied with the mounting kit.

The silicon power rectifier bridge is fastened to the side of the box as in the photos. It just fits, so a piece of electrical tape across the bottom terminal is good insurance against a short. Remaining construction is uncomplicated. The transistor's electrical connections are on flexible leads under C3 and C4.

There are unlimited uses and variations to the basic supply shown here. I use this particular unit to power a 10-meter mobile 2E26 transmitter with a transistor modulator. The high frequency circuit has only two rf tubes; the remaining parts of the rig use transistors. If you hear W1MCA, give us a call! END



Part I—It's summer, and the portable radio is back again. Here's how you can get those sets fixed faster and better

3-WAY PORTABLES

By JACK DARR

Tips and Techniques

ALTHOUGH the transistor radio is making great inroads into the new-radio market, a tremendous number of tube type portables are still in use. There are certainly enough to provide a highly profitable source of income for the service technician who can make them perform. The low power available and the limited antenna system make it imperative that each set be in 100% perfect condition if it is to work at all!

Servicing techniques used with these sets are slightly different from those used with home or auto radios. Several additional points must be checked to see that the finished job meets the necessary standards.

Performance standards which must be met are: selectivity, sensitivity and power output, just as in any radio. In addition, the special power supply used in these sets must meet certain requirements. Chief among these is its voltage tolerance—the power supply must furnish correct operating voltages for the set over a given range of supply voltage. In normal sets, this range is from 105–120 volts. In actual service work, the set must be made to operate over a range of 100–120 volts, without going either too high or too low in power output.

By "too high or too low", we do not mean the B-voltage, but the much more critical filament voltage. The circuit used in almost all of these sets derives filament voltage for the battery type tubes from the high-voltage supply through a dropping resistor, as shown in Fig. 1. Thus, the filament string serves as a bleeder across the B-voltage. Although there are many variations of this circuit, they can be traced back to this one fundamental type.

Note the shunt resistor shown across the audio tube's heater tap. Since the current drawn by the string is only 50 ma, the shunt resistor is included to compensate for the plate current drawn by the audio output tube. This current, which may go as high as 10–15 ma, if allowed to flow through the last half of the filament, will cause a momentary overload and in time blow this half of the heater. At a total current of 50 ma, 10 ma is a 20% overload! In some of the older circuits shunts were used across tubes farther along in the string.

Regardless of the presence of shunts, the actual heater voltage measured across a tube is the final criterion to use in judging power supply performance. The voltage tolerance of these little tubes is not nearly so large as that of their ac-powered counterparts. A 50L6, for instance, will work well from 40 to 60 volts or more. By contrast, the 1A7 or 1R5 used as an oscillator mixer in a portable has a normal operating range cutoff of 1.1 to a maximum of 1.4 volts! Below 1.1 volts, the tube's g_m is so low that the oscillator refuses to function. Above 1.4, the delicate filament's life is shortened *very rapidly!* Therefore, this voltage is one which the technician *must* check very closely each time a set is serviced, to avoid short tube life or very poor performance. An accurate low-range voltmeter is a must. (A quick check on the low range of a voltmeter is the open-circuit voltage of a *brand-new* D flashlight battery—1.56–1.58 volts.) The power supply must not overload the tubes at the upper limit, 120 volts, nor underrate them at the lower limit of 105 volts on the input.

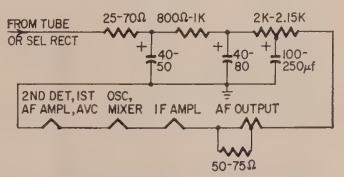


Fig. 1—Basic circuit of typical three-way portable's power supply.

Initial tests

When a set is brought in for service, the quickest check is an operating one. An autotransformer, to vary the applied voltage, is an indispensable tool—one will be discussed later. If the power supply is drawing current (indicated by a slight dip in the autotransformer's meter reading when the set is turned on), but no sound is heard, try increasing the line voltage by 5 or 10 volts. If the set plays with a high line voltage, but not at normal voltage, it means that either the power supply or the oscillator tube is below par. When testing, do not keep the line voltage above normal long or the tubes may go.

The easiest way to isolate the weak part is to replace the oscillator tube. If this restores performance at normal line voltage and the set continues to play with the line lowered to 105 volts, the power supply is OK. If the new tube fails to eliminate the difficulty, the power supply is probably weak. (This is assuming that the other tubes have been checked to see that none of them are dead or shorted.) We are discussing oscillator power supply failure because it is probably the most common defect encountered by the technician.

Checking the power supply

To check the power supply, remove the set from its cabinet, a procedure often easier described than done, and measure the output voltage of the selenium rectifier. Normal voltage at this point, junction of R1, R2 and C1 in Fig. 2, with a 117-volt input should be about 130 dc. If this dc voltage is less than the applied line voltage, the power supply is weak and trouble may be expected. Typical voltage readings of a weak rectifier will be about 100 volts dc with a 117-volt line. This lowers the filament voltage too much and the set stops working because of oscillator

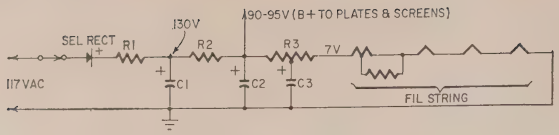


Fig. 2—Typical voltages found in portable power supply.

failure. Voltages may be measured across individual tube sockets, but it is much safer to take this reading at the rectifier, due to the extremely crowded chassis of the average portable. Probing about in those close quarters may result in blowing one or more tubes!

The low voltage may be due to any of several common troubles. In order of their frequency of occurrence (see Fig. 2): a weak selenium rectifier, low capacitance in the input filter capacitor, (C1) or a defective surge resistor (R1). This surge resistor protects the filter capacitors from the high initial surge of current when the set is turned on. If it appears charred or discolored, check the voltage drop across it. The total current drawn from the rectifier will run around 70 ma, average. Therefore, the drop across the surge resistor, which has an average size of 30–40 ohms, should be small. If a large drop, more than a volt or two, is measured, replace it. *Be sure to duplicate the original value—all resistors used in this type of power supply are critical.*

A weak rectifier can be easily checked by substitution. Disconnect the load end of the rectifier, which usually has only one end of the surge resistor connected to it, and bridge in a new unit. This can be done safely by placing the new rectifier on the bench and connecting it into the circuit with a pair of short test leads, with insulated clips on each end. If the voltage output returns to normal, replace the rectifier. A special problem is often found here. For economy reasons, the original unit is usually a 65–75-ma type. These should always be replaced with a 100-ma unit for a greater safety factor and longer life. (Most technicians prefer a greater safety factor than drawing 70 ma from a 75-ma rectifier, anyhow!)

In many chassis a standard-size 100-ma unit will not fit, because of the small space allowed. This problem can be met by using either the encapsulated type of selenium rectifier which resembles a large tubular capacitor, or by substituting one of the new silicon units. These are no bigger than a fuse and may be mounted almost anywhere. They come with a special fuse type clip for mounting. If there is not enough room for this, special caps with leads may be slipped over the ends of the rectifier and the whole thing insulated with cambric spaghetti.

Check output voltages very carefully when replacing selenium rectifiers with silicon types—the lower rectifier drop and added current-carrying capacity may cause filter input voltage to rise above normal, resulting in an overload at normal input voltages. If this condition occurs, increase the size of the surge resistor to take care of the added voltage. Voltage at the filter input should be approximately 130, with a 117-volt ac line.

The B-plus section of the filter circuit is conventional. A single pi-section filter is generally used, with a 500–800-ohm resistor R2 replacing the filter choke. Filter capacitor values run from 30 to 50 μf for the input capacitor C1

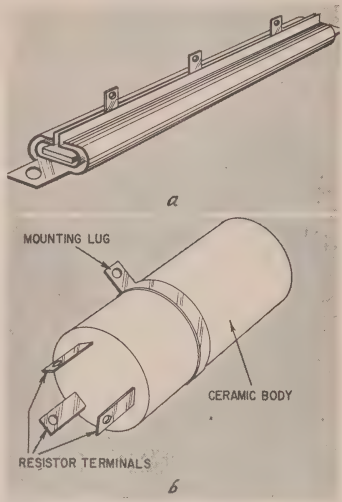


Fig. 3 — Filament dropping resistors: a—Candohm type of metal-clad unit found in older sets; b—ceramic-case type used in newer models.

and about the same at the output (C2), although some set makers use a very large unit for the output (up to 80 μf) to lower the hum level. Included in the assembly is the filament filter capacitor (C3) or capacitors, large units, 75–100 μf at 8–10 volts. C1 and C2, of course, have a working voltage of 150.

Lowered capacitance in the input filter impairs the performance of the power supply by decreasing the reservoir of capacitance needed to hold output dc voltage up. This is easily checked by bridging a good unit across the suspected one. Severe hum with normal voltage may indicate low capacitance in either C2 or C3. Bridge these also.

Filament dropping resistor

The most important resistor in the set is the large unit (R3) that drops the 90-volt output of the filter to the 6, 7.5 or 9 volts needed for the series-filament string. This resistor ranges from 2,000 to 2,200 ohms, depending upon the number of tubes used. It is always at least a 10-watt unit. Older sets used Candohms, while later models use a ceramic-cased tubular resistor, mounted through a hole in the chassis for better heat dissipation, with terminals on the bottom (see Fig. 3). A fairly common practice is to divide this resistor into two sections so a filter capacitor can be attached at the midpoint for better hum reduction (see Fig. 4). Due to the high susceptibility of battery type tubes to hum, the filament supply must be a very pure dc. Therefore the filament filter capacitors mentioned may be found divided into two sections of 100 μf each. One is connected to the tap of the resistor, while the other is connected to the filament of the audio output tube. This tube is always the first in the filament string.

Filament circuits of these sets display a great deal of uniformity in their arrangement of tubes—almost all have the tube filaments in the same order. The circuit is set up as in Fig. 5. Beginning at the end of the filament resistor, they run: audio output tube, if amplifier, mixer–oscillator, first audio–second detector. There is a good reason for this. By placing the audio output tube at the high end of the string, its filament is from 7 to 9 volts above chassis potential. This is the only tube in the string that requires any appreciable bias voltage. By returning the bottom end of its grid resistor to selected places along the heater string, any desired dc bias may be placed on the tube. In these tubes *the filament is the cathode* and any positive potential on it will be reflected as a negative bias voltage on the grid if the grid is returned to ground. (Because of the ac–dc power supply, this is usually a floating ground, seldom the chassis.)

Servicing procedure

The initial tests outlined earlier will reveal most power supply troubles in a matter of minutes. These make up the majority of service jobs. Because of the circuitry, these defects show up unmistakably when the line input

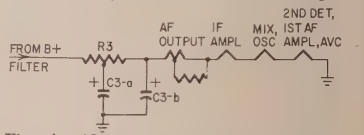


Fig. 4—Alternate arrangement of filament filter capacitors for better hum reduction. C3-a and C3-b may be 100 μf each. C3-a would be rated at 50–75 volts while C3-b would have a 10-volt rating.

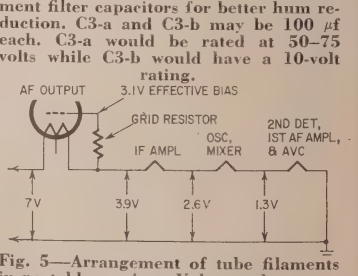


Fig. 5—Arrangement of tube filaments in portable receiver. Voltages shown are approximate and read with respect to B-minus.

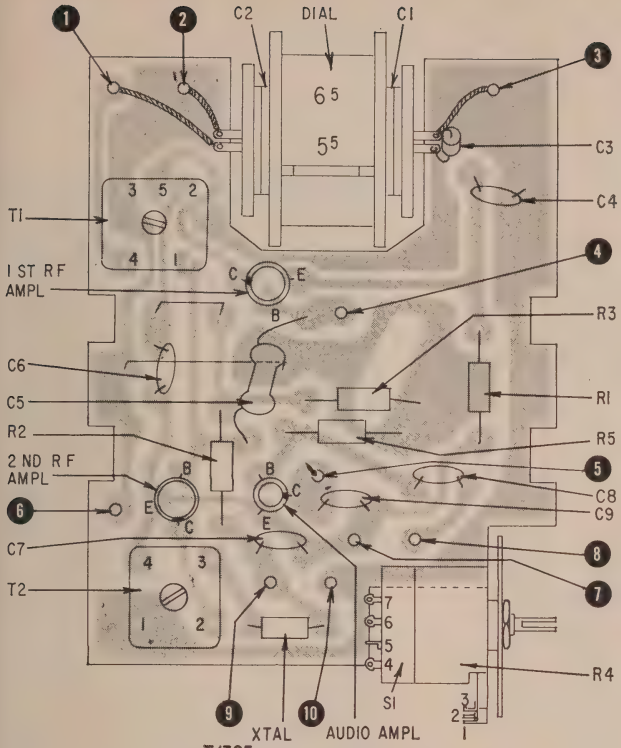
3-TRANSISTOR POCKET RADIO

THE *VeeP* is a three-transistor trf receiver with a crystal detector. An earpiece provides private listening. This Philco receiver measures only 3¾ x 2½ x 1 inches and is powered by two miniature mercury batteries. All components other than the ferrite antenna, tuning capacitor, volume control and batteries are mounted on a printed-circuit board.

When working on this set, remember that the commonest trouble in any transistor receiver is weak or dead batteries. These should be the first parts checked.

For alignment, use a 600-kc AM rf signal. Connect the generator's output to a loop of six to eight turns of insulated wire. Attenuate the generators output to a constant 0.63-volt level.

Production models of the VeeP use four different audio output transistors (see chart with circuit). No matter which is in the set, use a T-0041 for replacement, making sure a 180,000-ohm base bias resistor is in the circuit. END



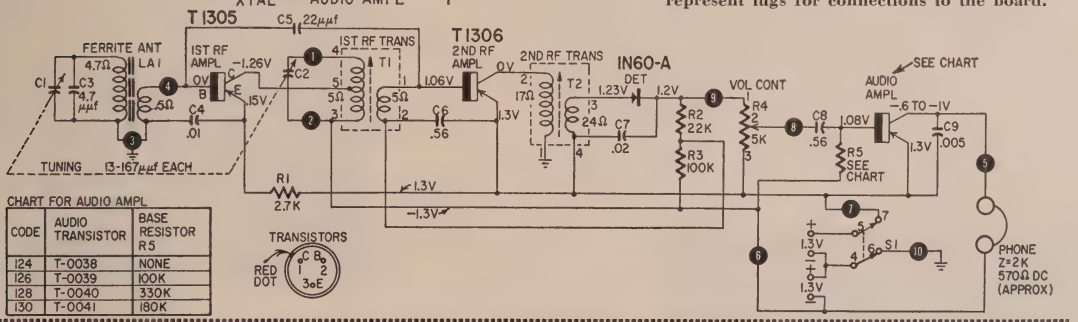


CHART FOR AUDIO AMPL

CODE	AUDIO TRANSISTOR	BASE RESISTOR R5
124	T-0038	NONE
126	T-0039	100K
128	T-0040	330K
130	T-0041	180K

Below—Schematic of the receiver; left—the printed-circuit board. The circled numerals represent lugs for connections to the board.

Three-way PORTABLES (Continued)

voltage is varied. Raising the line voltage and restoring performance is a sure indication of trouble and replacing the oscillator tube pinpoints it in a hurry.

When making parts replacements in these little sets, remember that some parts have large tolerances, others none at all. Filter capacitors, for instance, are not at all critical—a 50–30 at 150 volts may be used as a B-plus filter (C1 and C2) in practically all sets, regardless of the size of the original. Filament filter capacitors also have a wide tolerance range. So long as it keeps hum level below audibility, the capacitor is big enough! In certain hookups, the filament filters are separate from the B-plus block. In others, all are in the same can or tube.

A handy test is measuring the total filament voltage from the hot end of the filament string (the filament of the audio output tube) to ground or B-minus. Count the number of tubes and add up their filament voltages to determine the voltage needed. A standard circuit of a few years ago used three 1.4-volt and one 3-volt tube. This gives us 7.2 volts, full rating. Most designers allowed a bit of leeway for line-voltage variation, to prevent the filament voltage from rising above a safe level. Thus, a string like this would have a normal voltage across it of about 6–6.3, at normal input. This will place each of the tubes at about 85–90% normal filament, well within the tolerance range of 1.1 to 1.4 volts. The filaments used in these tubes are very delicate and even a slight overvoltage shortens their life tremendously.

For this reason, the value of the filament dropping resistor should *never* be changed. When making replacements, always use an exact replacement, electrically if not physically. Many sets will be found in which an amateur technician has attempted to raise the filament voltage by shunting this resistor —most of these will have from one to four dead tubes! If not, the tubes will probably be paralyzed from operation above the correct filament voltage—they will show filament continuity, but the output will be very small.

Next month we expect to continue with an eye toward excessive battery drain and what to do about it, alignment problems, some unusual troubles, cabinet repairs and test equipment. The construction of an autotransformer, invaluable in this type of work, is detailed. TO BE CONTINUED

what's new?

ELECTRONICS' ROLE among the instruments aboard Sputnik III is an important one. The numerous measuring and recording devices in the satellite—some completely hidden by the metal shell—are pointed out by the numbered lines. (1) a magnetometer for measuring earth's field, (2) photomultipliers that measure corpuscular irradiation of the sun, (3) solar batteries, (4) device for counting photons in cosmic rays, (5) magnetic ionized manometers, (6) ionic traps, (7) electrostatic fluxmeter, (8) mass spectrometer tubes, (9) device to detect heavy nuclear effect in cosmic rays, (10) apparatus for measuring the intensity of primary cosmic irradiation, (11) micro-meteor recorders.

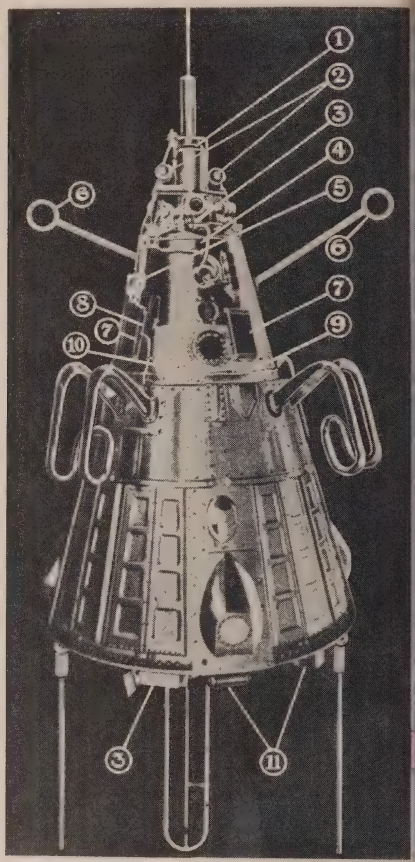
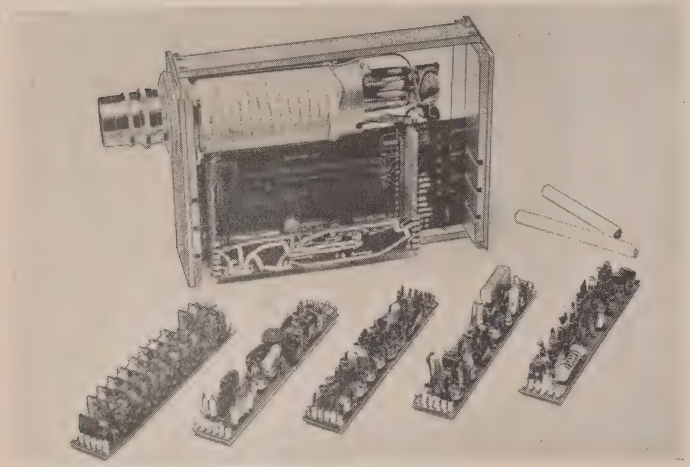
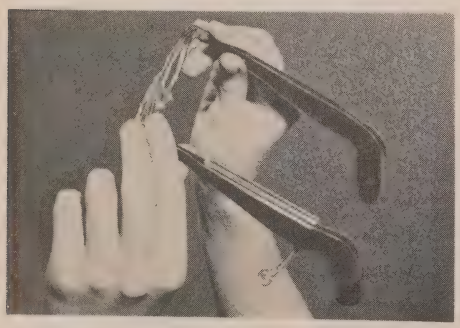


Photo by Soviphoto and Pravda.



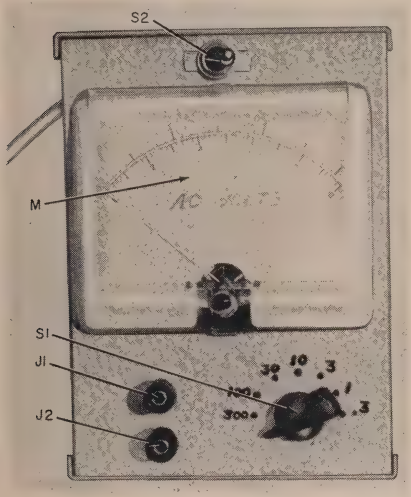
ALL-TRANSISTOR TV CAMERA which will operate for 30 minutes on a hearing-aid battery is being built by Dage Electronics Div., Thompson Products, Inc., for the Army Signal Corps. Of plug-in modular construction, printed-circuit boards contain the power supply, standard broadcast sync, video amplifier, etc. The Vidicon camera, also being offered for broadcast and industrial use at $8,000, may be operated from any 6-volt power source. It measures 2⅜ x 5⅜ x 7¾ inches.



SUN-POWERED HEARING AID with four tiny silicon solar cells in the temple of an eyeglass frame, is now being produced by Zenith Radio Corp. The frame also contains a miniature nickel-cadmium battery which is automatically recharged by sunlight and cuts into the circuit when light is insufficient to operate the aid. The hearing aid is a four-transistor design, and the assembly is available as a monaural or binaural unit.

WRAPAROUN TRANSMITTING A TENNA for TV chann 2–6, developed by Gene Electric, consists of a c per-clad steel helix coi around the upper section the antenna tower. Dev oped by a team of G-E en neers headed by L. Krause and R. E. Fisk, prototype antenna is sho here in a horizontal positi at G-E's new test site Cazenovia, N. Y. Design to cut costs, it requires one feed point, as oppos to 16 for a comparable b wing type. The first such tenna is being built for channel-2 station.

Author's original unit was not calibrated for db measurements.



BUILD an AUDIO VTVM

One-tube circuit covers a range of .03 to 300 volts for all audio measurements

By FORREST H. FRANTZ, SR.

AN audio vtvm is a valuable addition to the hi-fi enthusiast's, hobbyist's or technician's equipment. This instrument leads a many-sided life. It can be used to measure ac voltages, audio amplifier gain and amplifier frequency response. It is often used as a signal tracer and ac null detector. This article describes a simple, compact and inexpensive one-tube audio vtvm and discusses its features and uses.

An audio voltmeter must meet three basic requirements that a conventional ac voltmeter does not. Its input impedance must be high (at least 1 megohm) to prevent excessive audio circuit loading. Its lower scale limit must extend to lower ranges (at least down to 0.3 volt on the lowest scale). And its frequency response must be flat beyond the limits of the audio range (at least from 15 to 30,000 cycles). The block diagram of Fig. 1 shows the arrangement usually used.

Circuitry and construction aids

The voltage divider on this meter (see Fig. 2) consists of resistors R1 through R9 and switch S1. The values shown are for standard 1% resistors and are chosen for 10-decibel range steps. This gives good scale overlap so that any voltage between .012 and 300 can be read in the upper 68% of the meter scale. Another advantage of this arrangement is that a single decibel scale on the meter is good for all switch positions. The meter voltage scales are 0–10 and 0–3.

This voltmeter has a two-stage cas-

(*Continued on Page 74*)

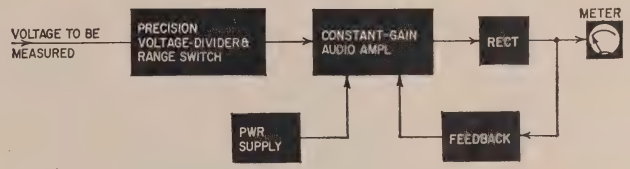
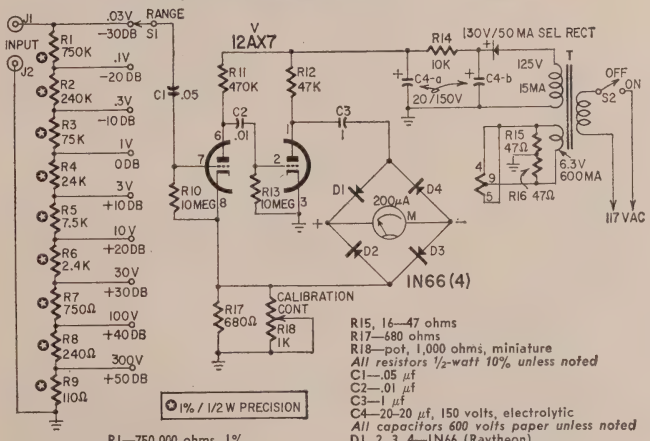


Fig. 1—Block diagram of an audio vtvm.



R1—750,000 ohms, 1%
R2—240,000 ohms, 1%
R3—75,000 ohms, 1%
R4—24,000 ohms, 1%
R5—7,500 ohms, 1%
R6—2,400 ohms, 1%
R7—750 ohms, 1%
R8—240 ohms, 1%
R9—110 ohms
R10, 13—10 megohms
R11—470,000 ohms
R12—47,000 ohms
R14—10,000 ohms
R15, 16—47 ohms
R17—680 ohms
R18—pot, 1,000 ohms, miniature
All resistors ½-watt 10% unless noted
C1—.05 μf
C2—.01 μf
C3—1 μf
C4—20-20 μf, 150 volts, electrolytic
All capacitors 600 volts paper unless noted
D1, 2, 3, 4—1N66 (Raytheon)
J1, 2—3-way binding posts
M—200-μa dc meter
RECT—selenium, 130 volts, 50 ma
S1—9-position single-pole rotary
S2—spst toggle
T—power transformer: primary, 117 volts; secondary, 125 volts, 15 ma; 6.3 volts, 600 ma
V—12AX7
Case, 3 x 5 x 7 inches
Chassis
Socket, 9-pin miniature with shield
Miscellaneous hardware

Fig. 2—Circuit of the one-tube unit.

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An exciting development in the Heathkit test instrument line is the introduction of the Heathkit model OP-1 Professional Oscilloscope. Emphasizing complete flexibility in any application, the OP-1 features DC coupled amplifiers and also DC coupled CRT tube un-blanking. The triggered sweep circuit will operate on either internal or external signals and may be either AC or DC coupled. The polarity of the triggering signal may also be selected, and any point on the wave form may be selected for the start of the sweep by using the "triggering level" control. An automatic position is also provided, in which the sweep recurs at a 50 cycle rate, but can be driven over a wide range of frequencies with no additional adjustments. The sweep frequencies are provided by switch-selected base rates of 2 and .2 milliseconds/CM, and 20, 2, and 1 microseconds/CM, in conjunction with a continuously variable 10 to 1 multiplier. Sweep frequencies are calibrated to within 10% at all control settings, and the sweep frequency may be reduced by adding capacity to the "ext. cap" binding post on the front panel. A 5ADP2 flat face CR tube is used for accurate readings on an edge lighted grid screen. A high quality conetic-fernetic CR tube shield prevents stray AC fields from distorting trace. A 12-position vertical attenuator is calibrated in volts-per-CM and the horizontal sweep is calibrated in time-per-CM. Prewired terminal boards are used for rapid, easy assembly of all critical circuits. Simply install and connect the color coded leads. Power supply is transformer operated utilizing silicon diode rectifiers and is fused for protection. Under development for over a year the OP-1 promises outstanding results in any application requiring the use of an oscilloscope.

HEATHKIT OP-1 $179.95

Here's the scope you've been waiting for!

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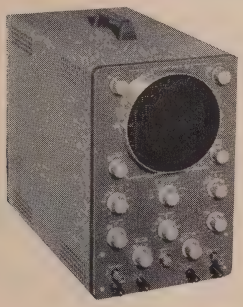

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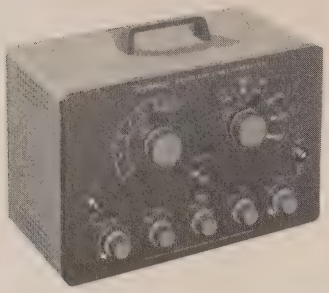
Top quality features at half the cost of ordinary equipment sum up the advantages of this popular kit. Critical observations in your laboratory or shop are handled easily, with clear, sharp pattern displays in every application. Vertical frequency response extends from 3 CPS to 5 mc +1.5 db —5 db without extra switching. Response is down only 2.2 db at 3.58 mc. The Heath patented sweep circuit functions effectively from 10 CPS to better than 500 kc in five steps, giving you 5 times the usual sweep obtained in other scopes. An automatic sync circuit with self-limiting cathode follower provides excellent linearity and lock-in characteristics. Extremely short retrace time and efficient blanking action. Both vertical and horizontal output amplifiers are push-pull and the scope incorporates a 1 V peak-to-peak calibrating source, step attenuated and frequency compensated vertical input, plastic molded capacitors and top quality parts throughout. The 11-tube circuit features a 5UP1 cathode ray tube, and provision is made for Z-axis input for intensity modulation of the beam. Frequency response of the horizontal amplifier is within ±1 db from 1 CPS to 200 kc. Horizontal sensitivity is 0.3 volts RMS per inch. Construction is simplified through the use of two metal circuit boards and precut, cable wiring harness. Shpg. Wt. 22 lbs.

GENERAL PURPOSE 5" OSCILLOSCOPE KIT

For servicing and routine laboratory work this fine kit is a favorite with technicians throughout the country. It incorporates many extras not expected at this low price. Features wide vertical amplifier frequency response, extended sweep generator operation, and improved stability. Frequency response of the vertical amplifier is within ± 3 db from 4 CPS to 1.2 mc. Vertical sensitivity is .09 volts RMS per inch at 1 kc. Sweep generator functions reliably from 20 CPS to over 150 kc. A modern etched circuit board is featured for high stability and reduces assembly time considerably. Standard components are mounted on this board with each position clearly marked preventing wiring errors. Both vertical and horizontal amplifiers are push-pull types. Uses a 5BP1 CRT. Provision for external or internal sweep or sync, built in 1 V peak-to-peak reference voltage and calibrated grid screen. An adjustable "spot shape" control is provided to insure a sharp trace. Input to the vertical amplifiers is through a step attenuated, frequency compensated circuit. The OM-3 is an extremely versatile instrument and has a multitude of practical uses in electronic testing fields. Particularly useful in alignment of television receivers, for testing audio amplifiers and circuits, and checking the quality of modulated RF signals in Ham Radio transmitters. Shpg. Wt. 22 lbs.

Equip Your Service Bench...



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★ 10 VERTICAL COLOR BARS
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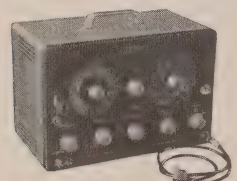
COLOR BAR AND DOT GENERATOR KIT

Colored television is now a reality and as the number of these sets increase the need for a reliable service instrument is apparent. Nothing on the market . . . in this type of generator has as many features as the CD-1 at such a tremendous price saving. This unit combines two basic color service instruments, a color bar generator, and white dot generator in one versatile portable unit which has crystal controlled accuracy and stability for steady locked-in patterns (requires no external sync leads). Color receivers converged with the CD-1 will still be converged properly on a television program from the station. The 13-tube circuit has been carefully laid out for ease of assembly and provides choice of six different patterns. Produces white-dots, cross hatch, horizontal and vertical bars, ten vertical color bars, and a new shading bar pattern for screen and background adjustments. Variable RF output on any channel from 2 to 6. Positive or negative video output, variable from 0 to 10 volts peak-to-peak. Crystal controlled sound carrier with off-on switch. Voltage regulated power supply uses long-life silicon rectifiers. Kit includes three crystals and test lead, plus an information packed instruction manual covering convergence, and screen and background adjustments of a color TV set. Compare with other generators on the market and you will see that this instrument is loaded with extras and top quality all the way through. Shpg. Wt. 13 lbs.



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TV ALIGNMENT GENERATOR KIT

This generator has many special design features for flexible, easy operation and reliability. The all-electronic sweep circuit insures stability and covers 3.6 mc to 220 mc in four bands. Sweep deviation is controllable from 0 to 42 mc. Crystal and variable marker oscillators are built in. Crystal (included with kit) provides output at 4.5 mc and multiples thereof. Variable marker provides output from 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking and phasing control also provided. A truly outstanding number of features at a tremendous price saving. Shpg. Wt. 16 lbs.

SINE-SQUARE GENERATOR KIT

High quality sine and square waves are produced by this generator over a wide range. Frequency response is ±1.5 db from 20 CPS to 1 mc on both sine and square waves, with less than .25% sine wave distortion, 20 to 20,000 CPS. Output impedance is 600 ohms on sine wave and 50 ohms on square wave (except on 10 volt range). Square wave rise time less than .15 microseconds. Five-position bandswitch—continuously variable tuning—shielded oscillator circuit—separate step and variable output attenuators in ranges of 10, 1 and .1 volts with extra range of .01 volt on sine wave. Shpg. Wt. 12 lbs.

20,000 OHMS/VOLT VOM KIT

This meter is ideal for use in field applications where accuracy is important. Employs a 50 ua 4½" meter, and features 1% precision multiplier resistors for high accuracy. Requires no external power for operation (batteries supplied). Sensitivity is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5,000 volts AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are x 1, x 100 and x 10,000 Covers -10 db to +65 db. Batteries and test leads are also included with this kit. Shpg. Wt. 6 lbs.

HANDITESTER KIT

Small enough to carry with you wherever you go, this fine handitester is ideal for use in portable applications when making tests away from the work bench or as an "extra" meter in the service shop, when the main instruments are occupied. The combination function-range switch simplifies operation. Measures AC or DC voltage from 0-10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 and 0-300,000. Top quality precision components employed throughout. Very popular with home experimenters and electricians. Shpg. Wt. 3 lbs.

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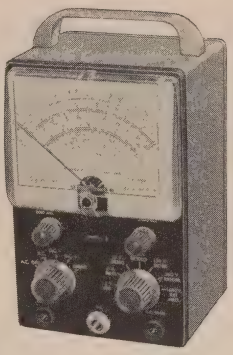
The fact that this instrument is outselling all other VTVM's says a great deal about its accuracy, reliability, and overall quality. The precision and quality of the components used in this VTVM cannot be duplicated at this price through any other source. Its attractive appearance as well as its performance will make you proud to own it. A large 4½" panel meter is used for indication, with clear, sharp calibrations for all ranges. Front panel controls consist of a rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit. An etched circuit board is employed for most of the circuitry, cutting assembly time and eliminating the possibility of wiring errors. It also assures duplication of laboratory instrument performance. This multi-function VTVM will measure AC voltage (RMS), AC voltage (peak-to-peak), DC voltage and resistance. There are 7 AC (RMS) and DC voltage ranges of 1.5, 5, 15, 50, 150, 500 and 1500. In addition there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400 and 4,000. Seven ohmmeter ranges providing multiplying factors of x 1, x 10, x 100, x 1000, x 10 k, x 100 k and x 1 megohm. Center scale resistance readings are 10, 100, 1000, 10 k, 100 k ohms, 1 megohm and 10 megohms. A zero-center scale db range is also provided. Battery and test leads included with kit. Shpg. Wt. 7 lbs.



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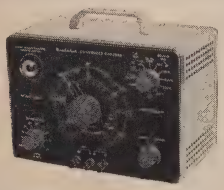

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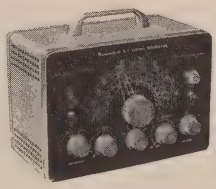

HEATHKIT SG-8 **$19.50**

Easy-to-build—prewound and calibrated coils

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately. Capacity measurements are made in four ranges of .00001 mfd-.005 mfd; .001 mfd-.5 mfd; .1 mfd-50 mfd; 20 mfd-1,000 mfd. Checks paper, mica, ceramic, and electrolytic condensers. Leakage test provides switch selection of five polarizing voltages, 25 volts to 450 volts DC to indicate condenser operating quality under actual load conditions. Electron beam "eye" tube indicates balance and leakage. A spring return test switch automatically discharges condenser under test and eliminates shock hazard to the operator. Measures resistance from 100 ohms to 5 megohms in two ranges. Shpg. Wt. 7 lbs.

VISUAL-AURAL SIGNAL TRACER KIT

Here is a brand new signal tracer completely redesigned with compact dimensions and new circuit layout. Features built-in speaker and electron beam "eye" tube for signal indication and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. RF and audio inputs are provided in one convenient probe with switch on probe to select either input. Useful for checking microphones, phono cartridges, record changers, tuners, etc. Makes a handy substitution speaker for servicing TV sets at the shop. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 6 lbs.

RF SIGNAL GENERATOR KIT

Save valuable time in aligning RF tuned circuits of all kinds with this easy-to-use kit. Also a quick way to trace signals in faulty RF, IF and audio circuits. Designed for general service applications-the SG-8 covers 160 kc to 110 mc on fundamentals in five bands, and from 110 mc to 220 mc on calibrated harmonics. The entire oscillator circuit is built on a special sub-chassis, using prewound and calibrated coils. No further calibration is required so it is ready to use as soon as construction is completed. RF output is in excess of 100,000 microvolts, controlled by both step and continuously variable controls. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

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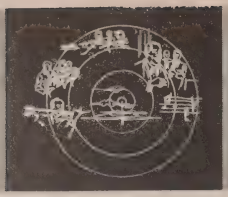

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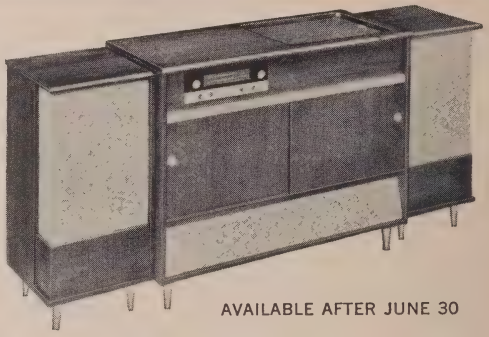

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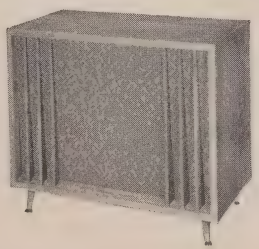
Imagine! . . . Stereophonic sound in your own home. This superbly designed cabinet holds all of your hi-fi stereo equipment and lends striking elegance to your living room. The attractive gold and black panels, trim and hardware brilliantly highlight the overall effect. Rich toned grille cloth, flecked in gold and black, complement the cabinet. The unit has ample room provided for an AM-FM tuner, tape deck, stereo preamplifier, amplifiers, record changer, record storage and speakers. Beautifully grained ¾" solid core Philippine mahogany or select birch plywood is used for construction. The top features a shaped edge and sliding top panel for easy access to the stereo tape deck and stereo preamplifier. Sliding doors are employed for convenient front access to the changer and record storage compartment. All parts of the cabinet are precut and predrilled for simple assembly. The speaker wings and center cabinet may be purchased separately if desired. Note: the kit is delivered equipped with panels precut to accommodate Heathkit components and also blank panels to cut out for your own equipment. Measurements of the individual component areas follow: tape deck and preamplifier area 20¾" L. x 17¾" W. x 10" D., record changer area 21" W. x 16" D. x 9⅝" H., record storage area 22⅝" W. x 14½" H. x 12½" D., speaker wing area (inside) 14" W. x 29½" H. x 15¾" D., AM-FM Tuner area 20½" W. x 5¼" H. x 14" D., amplifier (2 areas) 15¼" W. x 10¾" H. x 13¼" D.

Model HH-1B Birch
Model HH-1M Mahogany
Now only **$299.95** each



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OPTIONAL LEGS EXTRA

Economical Hi-Fi For Your Home

"LEGATO" HI-FI SPEAKER SYSTEM KIT

The increasing sales of the Legato has made more economical quantity production possible so we are passing the savings on to you by offering you this magnificent speaker system at a reduced price. Truly a "queen" among hi-fi speaker systems, the Legato was specially designed to meet and surpass the most stringent requirements of high fidelity sound reproduction. Two 15" Altec Lansing low frequency drivers cover frequencies of 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. A unique crossover network is built in making electronic crossovers unnecessary. Internal reflections are absorbed by splayed back panel and a 3" fiber glass lining. The Legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Cabinet construction is ¾" veneer surface plywood in either African mahogany or white birch and measures 41" L. x 22¼" D. x 34" H. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

True high fidelity performance at modest cost make this basic speaker system a spectacular buy for any hi-fi enthusiast. The amazing performance of this popular kit is made possible by the use of high quality speakers in an enclosure specially designed to receive them. The cabinet is a ducted port bass reflex type enclosure 11½" H. x 23" W. x 11¾" D. It features an 8" mid range woofer to cover 50 to 1600 CPS and a compression-type tweeter with flared horn covering 1600 to 12,000 CPS. Both speakers are by Jensen. The adjustable flared tweeter horn allows speaker to be used in either upright or horizontal position. The cabinet is constructed of ½" veneer surfaced plywood suitable for light or dark finish of your choice. All wood parts are precut and predrilled for easy assembly. Shpg. Wt. 25 lbs.

Attractive brass tip accessory legs convert SS-2 into attractive consolette. Legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26 $4.95

with a Heathkit Stereo System

HEATHKIT

HIGH FIDELITY STEREO TAPE DECK KIT

For your unparalleled enjoyment in the world of stereophonic sound Heathkit brings you an all new stereo tape deck. This tape deck is a precision engineered instrument providing monaural record/playback, and stereo playback of prerecorded tapes. Incorporates three separate heads, erase-record-stereo playback (stacked). The mechanical tape deck assembly is supplied complete. You build only the record and playback circuit employing two etched circuit boards for ease of wiring. Low noise EF-86 tubes in input stages and efficient push-pull bias-erase oscillator insures complete freedom from hum and noise in recording and playback. Provision made for 3¾ and 7½ IPS tape speed selected by a push button. Deck handles up to 7" reels of tape. Other features are: provision for monitoring tape while recording, built in VU meter for proper recording level, pause control for editing tape, "fast forward" and "rewind" control. Frequency response at 7½ IPS tape speed is ±2 db from 40 to 12,000 CPS, at 3¾ IPS speed 40 to 6,000 CPS. Signal-to-noise ratio is 55 decibels with less than 1% total harmonic distortion. NARTB tape playback equalization. A safety interlock button prevents accidentally switching to record position causing erasure of recorded tapes. Shpg. Wt. 33 lbs.

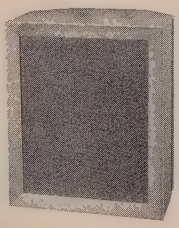
Model TR-1C monaural tape deck incorporates all of the features described for the model TR-1D with the exception of stereo playback. $131.95.

No. C-TR-1C conversion kit converts model TR-1C to include stereo function of model TR-1D. $15.95.

HEATHKIT TR-1D **$143.95**

Preassembled Tape Mechanism . . . You Build Only Electronic Circuit

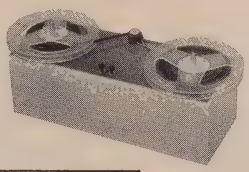
AVAILABLE AFTER JUNE 30



HEATHKIT SS-1B **$99.95**

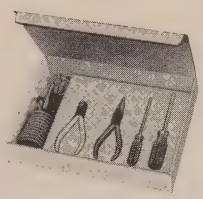
Fill out the Hi-Fi Range of Your SS-2 Speaker

AVAILABLE AFTER JUNE 30



HEATHKIT SW-1 PRICE TO BE ANNOUNCED

Save Time Rewinding Tape



HEATHKIT TK-1 **$9.95**

All The Tools You Need For Building Heathkits

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

This is not a complete speaker system in itself, but is designed to extend the range of the SS-2. The SS-1B uses a 15" woofer and a small super tweeter to supply the very high and very low frequencies to fill out the response of the basic SS-2. The SS-2 and SS-1B when used together, form an integrated four speaker system. The SS-2 and SS-1B combination provide an overall response of ±5 db from 35 to 16,000 CPS. The kit includes circuit for crossover at 600, 1600 and 4,000 CPS. Impedance is 16 ohms and power rating is 35 watts. A control is also provided to limit output of super tweeter. The handsome cabinet measures 29" H. x 23" W. x 17½" D. Constructed of beautiful ¾" veneer surface plywood. Complete step-by-step instructions make this kit easy to build. No woodworking experience required. Shpg. Wt. 80 lbs.

"SPEEDWINDER" KIT

This handy device leaves your tape recorder free for operation while it rewinds tape at the rate of 1200' in 40 seconds. Prevents unnecessary wear to the tape and recorder by eliminating wear against guides and heads. It will handle up to 10½" tape reels as well as 800' reels of 8 and 16 millimeter film. A very useful aid to operators of movie projection equipment. The Heathkit Speedwinder features an automatic shutoff which prevents whipping of tape when it has rewound. A manual shutoff is also provided. An automatic braking device is built in for protection against power failure. Driven by a heavy duty four pole motor. Handsome cabinet is constructed of furniture grade plywood. Step-by-step instructions are provided to make this kit easy to assemble even by one with no experience.

COMPLETE TOOL SET

A clear illustration of just how easy Heathkit building is. The pliers, diagonal sidecutters, two screw drivers and soldering iron are all the basic tools you need for building practically any Heathkit. Pliers and sidecutters are equipped with insulated rubber handles. The American Beauty soldering iron has a replaceable tip to facilitate cleaning. All the tools are of top quality case hardened steel for rugged duty and long life. With these simple, inexpensive tools in your hand you need not be afraid to tackle the most elaborate kit. The manual included with this handy kit provides you with many useful tips on the use and care of your tools. It shows the all important step of making proper solder connections. A truly worthwhile investment for the beginner in electronic kit building. Shpg. Wt. 3 lbs.

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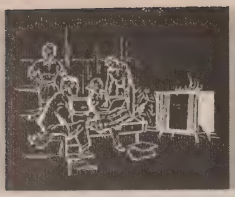


Plan Your Hi-Fi System...

AVAILABLE AFTER JUNE 30

HEATHKIT SP-2 **$56.95**

Model SP-1 (monaural) $37.95

Model C-SP-1 (converts SP-1 to SP-2) $21.95

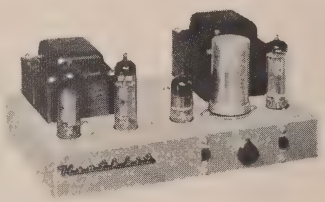
Control both stereo channels simply and conveniently

MONAURAL-STEREO PREAMPLIFIER KIT

This expertly designed preamplifier provides all the controls required for either standard monaural (single channel) or stereo (dual channel) sound reproduction. Features building block design . . . you can start with a basic preamplifier and add a second channel for stereo later on, without rewiring. Second channel plugs in for fast conversion. The complete model SP-2 (stereo) features twelve separate inputs, six on each channel with input level controls. Six dual-concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch (separate on-off switch). The function switch provides settings for stereo, two-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. Tape input has NARTB equalization and input selector provides for RIAA, LP, 78 record compensation. EF86 tubes are used in the input stages along with hum balance controls to assure low hum and noise. Two cathode follower outputs with level controls provided in addition to two separate tape outputs for stereo recording. A remote balance control with twenty feet of cable allows balancing the stereo system from listening position. Construction is greatly simplified through the use of two printed circuit boards (one in each channel) and encapsulated printed circuits. The beautiful vinyl clad steel cover has leather texture in black with inlaid gold design. Built-in power supply.

HEATHKIT WA-P2 **$19.75**

Finger-tip controls for your operating convenience



HEATHKIT UA-1 **$21.95**

A low cost versatile performer

"MASTER CONTROL" PREAMPLIFIER KIT

Designed as a control center for basic amplifiers the WA-P2 provides you with true high fidelity performance for the finest audio systems. Five switch-selected inputs accommodate a record changer, tape recorder, AM-FM tuner, TV receiver, microphone, etc., each with level control. Provision is also made for a tape recorder output. Ideal for "remote" installations, the WA-P2 features a low impedance cathode-follower output circuit allowing greater length of output lead. Full frequency response is obtained within ±1½ db from 15 to 35,000 CPS and will do full justice to the finest available program sources. Equalization is provided for records through separate turnover and rolloff switches for LP, RIAA, AES, and early 78's. A special hum balance control allows setting for minimum hum level. Power for operation is required from basic amplifier or external source. Shpg. Wt. 7 lbs.

"UNIVERSAL" 12-WATT AMPLIFIER KIT

A true high fidelity performer in every sense of the word, the UA-1 makes an ideal basic amplifier for any hi-fi system and is a perfect addition to gear your present hi-fi system for stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range (20 to 20,000 CPS) at full 12 watt output. The on-off switch is located right on the chassis and an octal socket is provided for connecting a preamplifier for remote control operation. The specially designed output transformer provides excellent stability and frequency response. Taps for 4, 8 and 16 ohm speakers, with switched damping for "unity" or "maximum" on the 16-ohm tap. An input level control is provided for use in wired music systems where a preamplifier is not required. This versatile unit is the latest addition to the fine line of Heathkit basic amplifiers. Shpg. Wt. 13 lbs.

With Flexible Heathkit Components

HEATHKIT

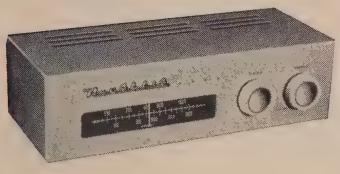
DELUXE AM-FM TUNER KIT

Outstanding features in both styling and circuitry are combined in this 16-tube deluxe AM-FM combination tuner to bring you the very finest in program sources, for your listening enjoyment. Features include three circuit boards for easy construction and high stability—prewired, prealigned FM front end—built-in AM rod antenna—tuning meter—AFC (automatic frequency control) with on-off switch and flywheel tuning. AM and FM circuits are separate and individually tuned making it ideal for stereo applications. Cathode follower outputs with individual controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. The unique IF limiter design automatically provides the number of limiting and IF stages required for smooth non-flutter reception. The silicon diode power supply is extremely conservatiyely rated and is fuse protected assuring long service life. A tuning meter shows when the station is tuned-in for clearest reception on AM or FM. Use of three circuit boards greatly simplifies construction of circuit, you do only a minimum of wiring. All IF transformers and coils are prealigned so it will be ready to operate as soon as construction is completed. Appearance of this top-quality unit is further enhanced by the vinyl-clad steel cover in black with inlaid gold design. A multiplex jack is provided for addition of converter unit to receive multiplex stereo broadcasts on FM. A top dollar value.

AVAILABLE AFTER JUNE 30

HEATHKIT PT-1 **$89.95**

A deluxe AM-FM tuner combination loaded with extras!



HEATHKIT BC-1A **$25.95**

Wide range broadcast reception

HEATHKIT FM-3A **$25.95**

Enjoy static-free FM entertainment

HIGH FIDELITY AM TUNER KIT

This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuit features broad bandwidth to assure low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc, with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent and the tuner covers the entire broadcast band from 550 to 1600 kc. Quiet performance is assured by a 6 db signal-to-noise ratio at 2.5 uv. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

HIGH FIDELITY FM TUNER KIT

FM programming, your least expensive source of high fidelity will provide you with years of real enjoyment. This beautifully styled FM tuner features broad-banded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting to pull in stations with clarity and full volume. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit, making special alignment equipment unnecessary. Edge-lighted glass slide rule dial for easy tuning. You need not wait to have FM in your home at this low price. Shpg. Wt. 8 lbs.

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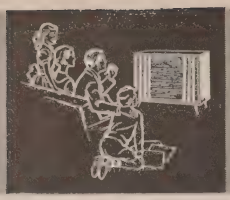
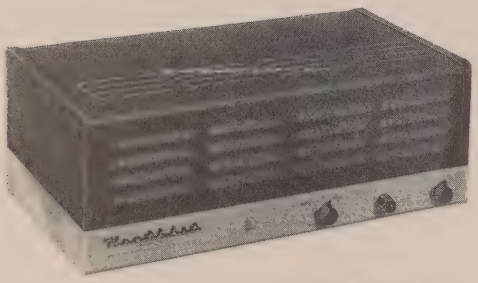


You can be sure you're buying High Fidelity



HEATHKIT W-7M **$54.95**

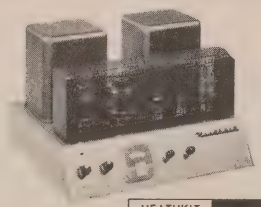
55 watts of hi-fi power at only $1 per watt

★ BEAUTIFULLY STYLED IN BLACK AND GOLD

★ UNITY OR MAXIMUM DAMPING

"EXTRA PERFORMANCE" 55 WATT HI-FI AMPLIFIER KIT

Another Heathkit first! An honestly rated high power amplifier with many top quality features at less than a dollar per watt. Full audio output is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Unique paired output connections permit instant switch selection of "unity" or "maximum" damping factors for all 4, 8 or 16 ohm speakers. Each output has an optimized current feedback circuit for unity damping so that there will be no compromise in performance when any of the impedances is used. This current feedback circuitry is entirely shorted out when not in use to obtain the highest possible damping factor. Features include level control and "on-off" switch right on the chassis plus provision for remote control from preamp, etc. Famous "bas-bal" circuit conveniently balances EL-34 output tubes. These heavy duty push-pull tubes operate into a high quality tapped-screen transformer designed especially for this unit. A 70-volt output on the transformer provides for P.A. or large music systems. The silicon diode power supply features a protection device that controls current until tubes have warmed up, greatly increasing service life of all components. The stylish black and gold case measures 6" H. x 8½" D. x 15" W. Convenient pilot light on the chassis. Thoughtful circuit layout makes this kit easy to build. Dollar for watt you can't beat this buy. Shipped express only, Shpg. Wt. 28 lbs.

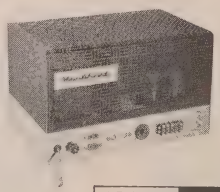


HEATHKIT W-6M **$109.95**

Plenty of Reserve Power Without Distortion

"HEAVY DUTY" 70-WATT HI-FI AMPLIFIER KIT

Here is an amplifier that will provide the extra "push" needed to drive any of the fine speaker systems available today, for truly fine performance at any power level. Silicon-diode rectifiers are used to assure long life and a heavy duty transformer gives you extremely good power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohms or 70 volt output and the correct feedback resistance. Frequency response at 1 watt is from 5 CPS to 80 kc with controlled HF rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 CPS and IM distortion is below 1%, 60 and 6,000 CPS. Hum and noise 88 db below full output. Metered balance circuit. Designed especially for easy assembly and years of dependable service. Shipped express only. Shpg. Wt. 52 lbs.

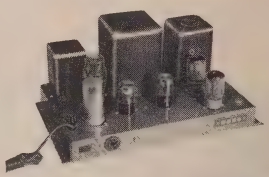


HEATHKIT W-5M **$59.75**

Top-Flight Performance for the Critical Listener

25-WATT HI-FI AMPLIFIER KIT

Considered top value in its power class by leading independent research organizations, the W-5M incorporates all the design features required by the super critical listener. Features include a specially designed Peerless output transformer and KT66 tubes. The circuit is rated at 25 watts and will follow instantaneous power peaks of a full orchestra up to 42 watts. A "tweeter saver" suppresses high frequency oscillation and a new type balancing circuit facilitates adjustment of the "dynamic" balance between output tubes. Frequency response is ±1 db from 5 CPS to 160,000 CPS at 1 watt and within 2 db from 20 to 20,000 CPS at full 25 watts output. Harmonic distortion is less than 1% at 25 watts and IM distortion is 1% at 20 watts (60 and 3,000 CPS, 4:1). Hum and noise are 99 db below 25 watts for truly quiet performance. Rich black and gold colored styling. Shipped express only. Shpg. Wt. 31 lbs.



HEATHKIT W4-AM **$39.75**

Faithful Sound Reproduction with Minimum Investment

20-WATT HI-FI AMPLIFIER KIT

This fine amplifier will amaze you with its outstanding performance. It features a true Williamson circuit with extended frequency response, low distortion, and low hum levels. Enjoy true hi-fi with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-Standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extends from 10 CPS to 100 kc within ±1 db at 1 watt assuring you of full coverage of the audio range. Clean, clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms to match the speaker system of your choice. An outstanding performer, this investment will bring you years of listening enjoyment. Shipped express only. Shpg. Wt. 28 lbs.

All basic amplifiers recommended for use with model WA-P2, SP-1 or SP-2 preamplifiers

...When You Buy Heathkits

HEATHKIT

"BOOKSHELF" 12-WATT AMPLIFIER KIT

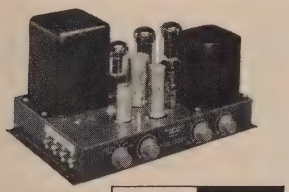
The model EA-2 combines eye-pleasing style and color with many extra features for high quality sound reproduction. This fine amplifier provides full range frequency response from 20 to 20,000 CPS within ±1 db. Harmonic distortion is less than 1% at full 12 watt output over the entire range (20-20,000 CPS). IM distortion is less than 1.5% at 12 watts with low hum and noise. Miniature tubes are used throughout the advanced circuitry, including EL84 output tubes in a push-pull tapped-screen output circuit using a special designed output transformer. Transformer has taps at 4, 8 and 16 ohms. The model EA-2 has its own built-in preamplifier with provision for three separate inputs, mag phono, crystal phono and tuner. The mag phono input features RIAA equalization. Separate bass and treble controls are provided with boost and cut action. A special hum-balance control assures quiet operation. The luxury styled cabinet has a smooth simulated leather texture in black with inlaid gold design and is constructed of vinyl plastic bonded to steel. It resists scuffing, wear, abrasion, and chemicals. The front panel features brushed-gold trim and buff knobs with gold inserts for a very pleasing appearance. An amber neon pilot lamp indicates when the amplifier is on. Cabinet measures 12½" W. x 3 3/16" D. x 4⅜" H. making it suitable for use on a bookshelf, end table, etc. High quality is emphasized throughout for performance matching amplifiers costing many times more. Shpg. Wt. 15 lbs.

HEATHKIT EA-2 **$27.95**

Combines beauty, style and quality

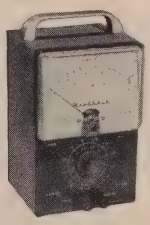
★ LESS THAN 1% DISTORTION AT FULL OUTPUT OVER ENTIRE AUDIO RANGE.

★ BUILT-IN PREAMPLIFIER



HEATHKIT A9-C **$35.50**

A Bargain Package of Power and Performance



HEATHKIT AV-3 **$29.95**

Invaluable for Hi-Fi Testing

HEATHKIT AW-1 **$29.50**

Measure Exact Power Output

GENERAL-PURPOSE 20-WATT AMPLIFIER KIT

The A9-C combines a preamplifier, main amplifier and power supply all on one chassis providing a compact unit to fill the need for a good high fidelity amplifier with a moderate cash investment. Designed primarily for home installations, it is also capable of fulfilling P.A. requirements. The preamplifier section features four separate switch selected inputs. Separate bass and treble tone controls offer 15 db boost and cut. A true high fidelity performer, the A9-C covers 20 to 20,000 CPS within ±1 db. Front panel is detachable, and can be installed on the outside of a cabinet where the chassis comes through, for custom installations. A fine unit with which to start your hi-fi system. Shpg. Wt. 23 lbs.

AUDIO VTVM KIT

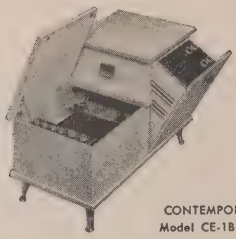
Critical AC voltage measurements are made easy with this high quality vacuum tube voltmeter which emphasizes stability, broad frequency response and sensitivity. Features large 4½" 200 microampere meter, with increased damping in the meter circuit for stability in low frequency tests. Extremely high voltage range handles measurements from a low value of 1 millivolt to a maximum of 300 volts. AC (RMS) voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 to +52 db. Employs 1% precision multiplier resistors for maximum accuracy. High input impedance (1 megohm at 1,000 CPS). Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

AUDIO WATTMETER KIT

Here is a fine meter to accurately measure output wattage. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w and 50 w full scale. Five switch selected db ranges cover −10 db to +30 db. All indications are read directly on the large 4½" 200 ua meter. Frequency response is ±1 db from 10 CPS to 250 kc. External or internal load resistors are selected with convenient front panel switch. Non-inductive load resistors are built in for 4, 8, 16 or 600 ohms impedance. Precision multiplier resistors are used for high accuracy and incorporates a crystal diode bridge for wide-range frequency response. Modern styling and convenient front panel design. Cabinet is ventilated to allow efficient cooling of load resistors. Shpg. Wt. 7 lbs.

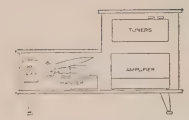
HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 20, Mich.**

Easy to Buy - Easy to Build - Easy to Use...



HEATHKIT
CE-1
$43.95 each

CONTEMPORARY
Model CE-1B Birch
Model CE-1M Mahogany

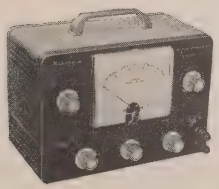


TRADITIONAL
Model CE-1T Mahogany

Combine all your Hi-Fi equipment in this attractive cabinet

CHAIRSIDE ENCLOSURE KIT

This Chairside Enclosure lets you combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house the AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit into the space provided. Adequate room is available in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. The enclosure is flexible enough to give you a large choice in component installation. If only one tuner and the preamplifier are used, the two units can be installed in the tilt-out drawer, or if more convenient, either unit can be placed in the space provided in front of the changer compartment. The tilt-out shelf can be installed on either right or left side and the lift-top lid is similarly designed to lift from either side depending on your choice during construction. Good ventilation is achieved through appropriately placed slots in the bottom and back of the enclosure. Overall dimensions are 18"W. x 24" H. x 35½" D. The changer compartment measures 17¾" L. x 16" W. x 9⅜" D. All parts are precut and predrilled for easy assembly and attractive hardware is supplied to match each style. The contemporary cabinet is available in either mahogany or birch and the traditional cabinet is available in mahogany only. Furniture grade plywood can be finished to your taste. Shpg. Wt. 46 lbs.

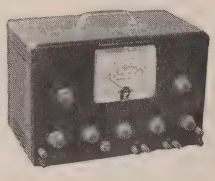


HEATHKIT
AG-9A
$34.50

Your own source of Hi-Fi audio signals

AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals from 10 CPS to 100 kc. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1, 3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 CPS. Shpg. Wt. 8 lbs.



HEATHKIT
AA-1
$49.95

3 Audio test instruments in one compact unit

AUDIO ANALYZER KIT

Complete high fidelity testing facilities are yours in the AA-1. It combines the functions of three separate instruments; an AC VTVM, audio wattmeter and a complete IM analyzer with filters and high and low frequency oscillators built in. VTVM ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Db scale reads from −65 to +52 dbm. Wattmeter ranges are: .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100% full scale. Provides internal load resistors of 4, 8, 16 or 600 ohms. Combining and consolidating functions reduces the number of test leads and controls required for the same test. Complete instructions are provided for easy assembly, also valuable information on use of instrument. Shpg. Wt. 13 lbs.

HEATHKIT
HD-1
$49.50

Check amplifier distortion quickly

HARMONIC DISTORTION METER KIT

Valuable in both designing and servicing of audio circuits, the HD-1 used with an audio signal generator, will accurately measure harmonic distortion at any or all frequencies between 20 and 20,000 CPS. Distortion is read on panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Full scale voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio is measured on a separate meter scale calibrated in db. Features high input impedance (300,000 ohms) and 1% precision resistors in the VTVM voltage divider circuit for excellent sensitivity and accuracy. High quality components insure years of dependable service. Complete instructions provided for easy assembly and operation. Shpg. Wt. 13 lbs.

Heathkits are Your Best Dollar Value

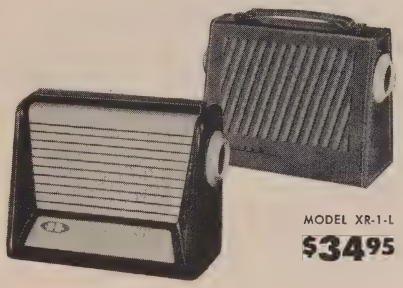
HEATHKIT

TRANSISTOR PORTABLE RADIO KIT

The overwhelming sales of this outstanding transistor portable have made a substantial price reduction possible . . . in addition, an all new plastic molded case adds the finishing touch to the exceptional circuitry. Six name-brand (Texas Instrument) transistors are used for extra good sensitivity and selectivity. The 4" x 6" PM speaker with heavy magnet provides excellent tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned so it is ready for service as soon as construction is completed. A touchup in alignment is easily accomplished on a station by following simple instructions in manual. Alignment tool furnished. Has built-in rod-type antenna for reception in all locations. Six standard size "D" flashlight cells are used for extremely long battery life (between 500 and 1000 hours) and they can be purchased almost anywhere. Cabinet is two-tone blue molded plastic with pull-out carrying handle. Dimensions are 9½" L. x 7¼" H. x 4" D. Shpg. Wt. 6 lbs.

Model XR-1-L: Identical to XR-1-P except in genuine leather case. Rich, warm sun-tan tone. Leather carrying strap included. Shpg. Wt. 7 lbs.

Leather Case: can be purchased separately if desired. Fits all XR-1P's and XR-1's. No. 93-1. Shpg. Wt. 3 lbs. $6.95.



MODEL XR-1-L
$34.95

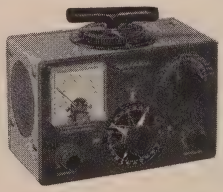
HEATHKIT XR-1-P **$29.95**

Newly designed plastic case . . . new low price!

★ 4" X 6" SPEAKER FOR "BIG SET" TONE
★ LONG BATTERY LIFE (500 to 1000 Hours)

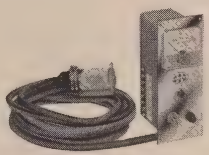
HEATHKIT CT-1 **$7.95**

Test condensers right in the circuit



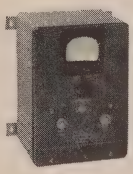
HEATHKIT DF-1 **$54.95**

Pin-point your exact location



HEATHKIT FD-1 **$35.95 each**
(6 volt model FD-1-6)
(12 volt model FD-1-12)

Detects gas fumes



HEATHKIT MC-1 **$42.95**

Save your boat batteries

IN-CIRCUIT CAPACI-TESTER KIT

Check most capacitors for "open" or "short" right in the circuit with this handy kit. Detects open capacitors from about 50 mmf up, not shunted by an excessively low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage nor check electrolytic condensers.) Employs a 60-cycle frequency for the short test and a 19 megacycle frequency for the open test. Uses electron beam "eye" tube for quick indication. Test leads included. Shpg. Wt. 5 lbs.

TRANSISTOR RADIO DIRECTION FINDER KIT

This transistor radio compass will double as a portable radio. Covers the standard broadcast band from 540 to 1600 kc. Ideal for use aboard boats and also on land by hunters, hikers, etc. A directional high-Q ferrite antenna rotates from the front panel to obtain a fix on a station. A 1 ma meter serves as null and tuning indicator. Prealigned IF transformers—six transistor circuit. Powered by tiny 9-volt battery with spare included. Dimensions 7½" W. x 5⅞" H. x 5⅜" D. Shpg. Wt. 5 lbs.

FUEL VAPOR DETECTOR KIT

Protect your boat and passengers against fire and explosion with one of these fuel vapor detector kits. Indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot lamp shows when the detector is operating. Easy to build and install, even by one not having previous experience. Operates from your boat battery. The kit is complete with heavy-duty neoprene insulated cable and includes spare detector unit. Shpg. Wt. 4 lbs.

MARINE CONVERTER KIT

Charge 6 or 12 volt batteries with this marine converter and battery charger. A panel mounted 25 ampere meter continuously monitors the charging current. Moisture and fungus proofed for rugged marine use. Convection cooling prevents unsafe temperature rise. The MC-1 has no moving parts, tubes nor blowers to wear out or break. Mounting brackets are supplied for easy installation on any boat. Ideal for keeping batteries fully charged or to supply extra current for appliances, Shpg. Wt. 16 lbs.

HEATH COMPANY • a subsidiary of Daystrom, Inc. • Benton Harbor 20, Mich.

New Styling - New Features...

HEATHKIT TX-1 **$229.50**

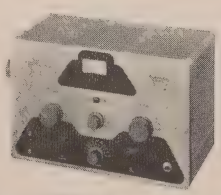
Complete Versatility for Top-Notch Amateur Communications

★ NEWLY DESIGNED VFO—ROTATING SLIDE RULE DIAL
★ MODERN STYLING—PROVISION FOR SSB ADAPTER

"APACHE" HAM TRANSMITTER KIT

Fresh out of the Heath Company laboratories, the brand-new "Apache" model TX-1 ham transmitter features modern styling and the latest in circuitry for extra fine performance. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. These SSB adapters will be available in the near future. A compact, stable and completely redesigned VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters. (11M with crystal control). This unit also has adjustable low level speech clipping and a low distortion modulator stage employing two of the new 6CA7/EL-34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. Shpg. Wt. 115 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.



HEATHKIT DX-20 **$35.95**

An Ideal Code Transmitter

HEATHKIT DX-100 **$189.50**

You'll be Proud to Own This Outstanding Performer

HEATHKIT DX-40 **$64.95**

Phone & CW Facilities at Low Cost

DX-20 CW TRANSMITTER KIT

Designed especially for CW work, the DX-20 features high efficiency at low cost. An ideal rig for the novice or advanced-class CW operator. Plate power input is 50 watts, and covers 80, 40, 20, 15, 11 and 10 meters with single knob bandswitching. Features a single 6DQ6A tube in the final amplifier stage and a 6CL6 as a crystal oscillator. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long service life. Complete shielding to minimize TVI. Removable metal pull-out plug on left end of cabinet provides access for crystal changing. Very easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

DX-100 PHONE AND CW TRANSMITTER KIT

Well known for its high quality and fine performance the DX-100 features a built-in VFO, modulator, and power supply, complete shielding to minimize TVI, and a pi network coupling to match impedances from 50 to 600 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW, for clean strong signals on all ham bands from 10 to 160 meters. Single knob bandswitching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. High quality components are used throughout, such as potted transformers, silver-plated or solid coin silver switch terminals, aluminum-heat dissipating caps on the final tubes, copper plated chassis, etc. Shpg. Wt. 107 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

DX-40 PHONE AND CW TRANSMITTER KIT

An outstanding buy in its power class the DX-40 provides both phone and CW operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 75 watt plate power input on CW, or controlled carrier modulation peaks up to 60 watts for phone operation. Modulator and power supplies are built in and single-knob bandswitching is combined with the pi network output circuit for complete operating convenience. Complete shielding to minimize TVI. Provision is made for three crystals. A four-position switch selects any of the three crystals or a jack for external VFO. Crystal sockets are reached through access door in rear of cabinet. High quality D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.

For Real Ham Enjoyment

HEATHKIT

"MOHAWK" HAM RECEIVER KIT

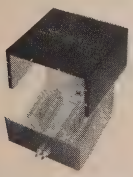
Here is a ham receiver that any radio operator would be proud to own. The "Mohawk" has all the functions required for high quality communications with clear, rock-steady reception on all bands. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all of the amateur frequencies from 160 through 10 meters on seven bands with an extra band calibrated to cover 6 and 2 meters using a converter. Receiver accommodations are provided for these converters which will be available in Heathkits soon. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely preassembled, wired and aligned front end coil assembly assures ease of construction and top performance of the finished unit. Other features include five selectivity positions from 5 kc to 500 CPS, bridged T-notch filter for maximum heterodyne rejection, and a built-in 100 kc crystal calibrator. The set provides a 10 db signal-to-noise ratio at less than 1 microvolt input. Front panel features S meter, separate RF, IF and AF gain controls, T-notch tuning, T-notch depth, ANL, AVC, BFO, bandswitch, tuning, antenna trimmer, calibrate set, calibrate on, CW-SSB-AM, receive-standby, upper-lower sideband, selectivity, phone jack and a wide band rotating slide rule type vernier tuning dial with easy to read calibrations. Shpg. Wt. 90 lbs.

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

HEATHKIT RX-1 **$274.95**

Now in Kit Form a Top Quality Ham Band Receiver

★ PREWIRED AND ALIGNED FRONT END COIL ASSEMBLY.
★ CRYSTAL CONTROLLED OSCILLATORS FOR DRIFT-FREE RECEPTION.

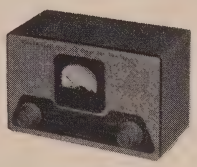


HEATHKIT B-1 **$8.95**

Get Proper Match Between Transmitter and Antenna

BALUN COIL KIT

Unbalanced coax lines used on the most modern transmitters can be matched to balance lines of either 75 or 300 ohms impedance by using the model B-1 Balun Coil Kit. Can be used with transmitters and receivers without adjustment over the frequency range of 80 through 10 meters, and will handle power inputs up to 200 watts. Cabinet size is 10" square by 5" D. and may be located any distance from the transmitter or antenna. A protective cover is supplied to prevent damage in outdoor installations. Shpg. Wt. 4 lbs.

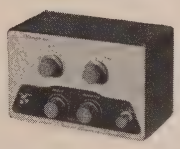


HEATHKIT AM-2 **$15.95**

Measure Standing Wave Ratio

REFLECTED POWER METER KIT

The match of your antenna transmission system can be checked by measuring the forward and reflected power or standing wave ratio from 1:1 to 6:1 with this fine unit. Designed to handle a peak power of well over 1 kilowatt of energy the AM-2 may be left in the antenna system feed line at all times. Band coverage is 160 meters through 2 meters. Input and output impedances for 50 or 75 ohm lines. No external power required for operation. Cabinet size is 7⅜" x 4 1/16" x 4⅝". Shpg. Wt. 3 lbs.

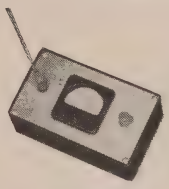


HEATHKIT VX-1 **$23.95**

Eliminates Hand Switching

ELECTRONIC VOICE CONTROL KIT

This unique device allows you to switch from receiver to transmitter merely by talking into your microphone . . . you get the advantage of "telephone-type conversation" as in single sideband but with regular AM transmission. The unit is adjustable to all conditions by sensitivity controls provided. A variable time delay control changes the "hold" time. Provision is made for receiver and speaker connections and also for a 117 volt antenna relay. Built-in power supply. Complete instructions provided. Shpg. Wt. 5 lbs.



HEATHKIT PM-1 **$14.95**

Quick Check of Transmitter Operation

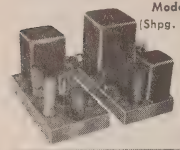
RF POWER METER KIT

This self contained unit requires no power for operation. You simply place it close to the transmitter antenna to sample the RF field which is then indicated on the panel meter. Operates with any transmitter having an output frequency between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Measures 3¾" W. x 6¼" L. x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 20, Mich.**

Choose from a wide variety of Heathkits

DUAL-CHASSIS 20 WATT HI-FI AMPLIFIER KIT

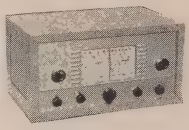


Model W3-AM
(Shpg. Wt. 29 lbs.)
$49.75

12" UTILITY SPEAKER

Model 401-6
(Shpg. Wt. 7 lbs.)
$7.50

ALL-BAND RADIO KIT

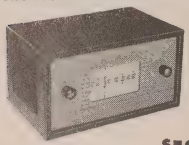


Model AR-3
(Shpg. Wt. 12 lbs.)
$29.95
(less cabinet)

CRYSTAL RADIO KIT

Model CR-1
(Shpg. Wt. 3 lbs.)
$7.95

BROADCAST BAND RADIO KIT

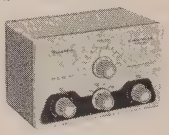


Model BR-2
(Shpg. Wt. 10 lbs.)
$18.95
(less cabinet)

ELECTRONIC CROSSOVER KIT

Model XO-1
(Shpg. Wt. 6 lbs.)
$18.95

"Q" MULTIPLIER KIT



Model QF-1
(Shpg. Wt. 3 lbs.)
$9.95

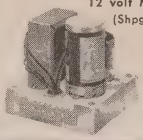
"AUTOMATIC" CONELRAD ALARM KIT

Model CA-1
(Shpg. Wt. 4 lbs.)
$13.95

GRID DIP METER KIT

Model GD-1B
(Shpg. Wt. 4 lbs.)
$21.95

VIBRATOR POWER SUPPLY KIT



6 volt Model VP-1-6
12 volt Model VP-1-12
(Shpg. Wt. 4 lbs.)
$7.95 ea.

VARIABLE FREQUENCY OSCILLATOR KIT

Model VF-1
(Shpg. Wt. 7 lbs.)
$19.50

PROFESSIONAL RADIATION COUNTER KIT

Model RC-1
(Shpg. Wt. 8 lbs.)
$79.95

ISOLATION TRANSFORMER KIT

Model IT-1
(Shpg. Wt. 9 lbs.)
$16.50

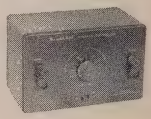
ELECTRONIC SWITCH KIT

Model S-3
(Shpg. Wt. 8 lbs.)
$21.95

REGULATED POWER SUPPLY KIT

Model PS-3
(Shpg. Wt. 17 lbs.)
$35.50

VOLTAGE CALIBRATOR KIT

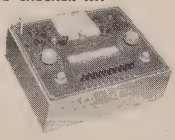


Model VC-3
(Shpg. Wt. 4 lbs.)
$12.50

DIRECT-READING CAPACITY METER KIT

Model CM-1
(Shpg. Wt. 7 lbs.)
$29.50

TUBE CHECKER KIT



Model TC-2
(Shpg. Wt. 12 lbs.)
$29.50

EASY TIME PAYMENTS

AVAILABLE FOR YOUR CONVENIENCE . . .

Any order totaling $90 or more can be paid for in small monthly payments (send for complete details).

RESISTANCE SUBSTITUTION BOX KIT

Model RS-1
(Shpg. Wt. 2 lbs.)
$5.50

CONDENSER SUBSTITUTION BOX KIT

Model CS-1
(Shpg. Wt. 2 lbs.)
$5.50

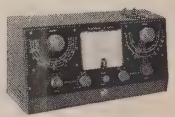
CATHODE RAY TUBE CHECKER KIT

Model CC-1
(Shpg. Wt. 10 lbs.)
$24.95

LABORATORY RF GENERATOR KIT

Model LG-1
(Shpg. Wt. 16 lbs.)
$48.95

"Q" METER KIT



Model QM-1
(Shpg. Wt. 14 lbs.)
$44.50

DECADE CONDENSER KIT

Model DC-1
(Shpg. Wt. 3 lbs.)
$16.50

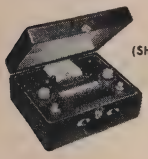
DECADE RESISTANCE KIT

Model DR-1
(Shpg. Wt. 4 lbs.)
$19.50

...to Fill Your Exact Needs

HEATHKIT

PORTABLE TUBE CHECKER KIT



Model TC-2P
(Shpg. Wt. 15 lbs.)

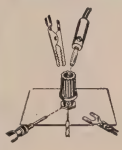
$34.50

TV PICTURE TUBE TEST ADAPTER FOR TC-2 AND TC-2P

Model 355
(Shpg. Wt. 1 lb.)

$4.50

BINDING POST KIT



Model 362
(Shpg. Wt. 1 lb.)

$4.00

BATTERY TESTER KIT

Model BT-1
(Shpg. Wt. 2 lbs.)

$8.50

ELECTRONIC IGNITION ANALYZER KIT

MODEL IA-1
(Shpg. Wt. 20 lbs.)

$59.95

SCOPE PROBES

Scope Demodulator Probe Kit
Model 337-C
(Shpg. Wt. 1 lb.)

$3.50

Low Capacity Probe Kit
Model 342
(Shpg. Wt. 1 lb.)

$3.50

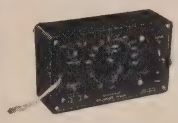
VTVM PROBES

30,000 Volt DC HV
Probe Kit No. 336
Shpg. Wt. 2 lbs. $4.50

Etched Circuit RF
Probe Kit No. 309-C
Shpg. Wt. 1 lb. $3.50

Peak-to-peak Voltage
Probe Kit No. 338-C
Shpg. Wt. 2 lbs. $5.50

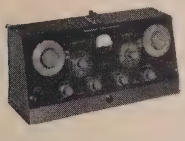
ENLARGER TIMER KIT



Model ET-1
(Shpg. Wt. 3 lbs.)

$11.50

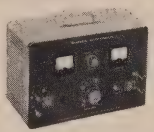
IMPEDANCE BRIDGE KIT



Model IB-2A
(Shpg. Wt. 12 lbs.)

$59.50

"LOW RIPPLE" BATTERY ELIMINATOR KIT



Model BE-5
(Shpg. Wt. 21 lbs.)

$39.95

ELECTRONIC ANALOG COMPUTER KIT
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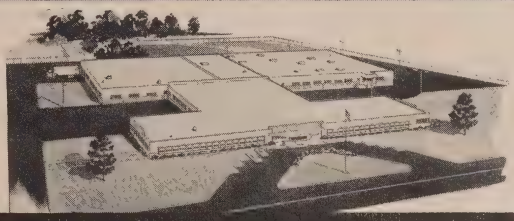

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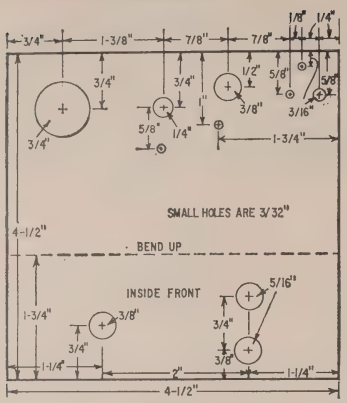


Fig. 3—Layout of the meter's internal chassis.

(*Continued from Page 57*)

caded triode amplifier. A dual triode 12AX7 does this job. The rectifier consists of four germanium diodes in a full-wave bridge circuit. Negative feedback from one of the rectifier input terminals to the cathode of the first triode section keeps the amplifier gain constant in spite of line-voltage fluctuations and changes in tube emission. It also increases the frequency range over which gain is constant and compensates for diode nonlinearity. The indicator is a 200-μa meter, necessary to maintain the instrument's linearity.

The actual construction and component placement in an audio vtvm can spell the difference between excellent and mediocre performance. The big problem is 60-cycle ac hum pickup, particularly by the voltage divider and first amplifier grid. The 60-cycle signal can be picked up from ac leads (117 and 6.3 volts) or the power transformer. Hum pickup manifests itself as a residual meter reading even when no voltage is applied to the instrument's input terminals. Build your audio vtvm in an aluminum case and use an aluminum chassis. This shields the instrument from external hum fields and decreases the chances of picking up hum from the power transformer's field. A steel chassis and case will increase coupling between the power-transformer field and the first amplifier grid, and invariably leads to trouble in compact ac vtvm's and amplifiers.

Now what about parts placement? Obviously, the power transformer should be as far from the input voltage divider and first amplifier grid circuit as possible and an aluminum shield should be provided. I did this by mounting my power transformer on the upper portion of the instrument case in the corner diagonally opposite the voltage divider and amplifier wiring. (See back-view photo of the instrument.) The intervening chassis acts as a shield.

All other power supply leads and components are mounted above the chassis too. The heater leads are twisted and brought under the chassis to the tube terminals to which they connect. These leads are placed so that they're dressed close to the aluminum chassis and case back when the back is attached. The tube is mounted opposite the power transformer and is shielded to preclude hum pickup at this point.

Underchassis leads are kept short and components are placed so they'll be as close to a metal surface of the chassis or case as possible. The only connection to the chassis is made at the input terminal. All ground connections are returned to one of the potentiometer terminals. Although the hum precautions may seem elaborate, *they're essential to satisfactory performance* in compact high-gain audio equipment. They're a matter of correct design and packaging, and they don't add to the cost nor complicate construction.

The chassis layout is shown in Fig. 3. The front side of the chassis may be used as a template for the switch and terminal holes on the front panel of the

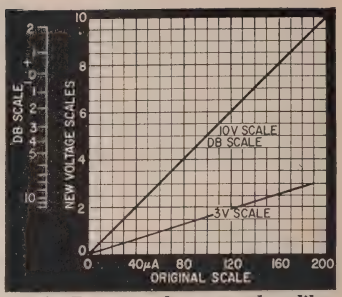


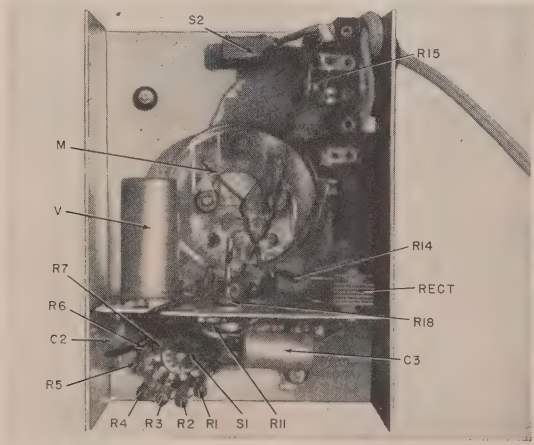
Fig. 4—Ranges and meter-scale calibration data.

case. The range switch and input terminals pass through the chassis and the case and hold them together. The meter mounting-hole positions will depend on the meter you use. Be sure to allow enough space above the meter to mount ON–OFF switch S2 on the front of the case and power transformer T on the side. Meter-scale information is given in Figs. 4 and 5.

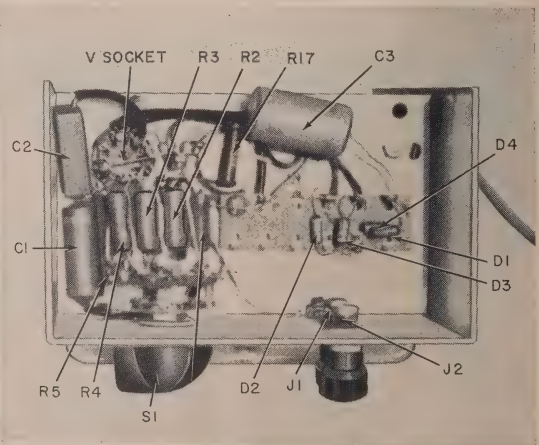
My audio vtvm was originally designed for a specific application that didn't require the .03-, 0.1-volt or decibel meter scales. My voltage divider was slightly different from that shown in the circuit and R18 was set for lower amplifier gain than a .03-volt bottom range requires.

Fig. 5 shows the meter face with the decibel scale added. Zero db corresponds to .001 watt (0.7746 volt) across 600 ohms. When making volume-level measurements read the db scale and note the db setting for RANGE switch S1. The true level in db is the *algebraic sum* of the scale reading and the db setting of the range selector. REMEMBER: To add numbers with like signs, find their sum and prefix with the common sign. When adding positive and negative numbers, subtract and prefix the sign of the larger number.

For example, if the meter reads −8 db on the +10 db range the true



A look inside the instrument's case.



Bottom view of the built-in chassis reveals the multiplier resistors.

Fig. 5—Meter scale as reconstructed using calibration chart in Fig. 4.

reading is +2 db (+10 − 8 = +2). Similarly, if the meter reads −5 db on the −10 db range, the true reading is −15 db.

Calibrating and using the meter

To calibrate this audio voltmeter, set the range switch to the 10-volt scale and connect the input terminals to a 6.3-volt transformer secondary. Adjust R18 till the meter reads 6.3 volts. The response of the meter will be within ±0.5 decibel from about 15 cycles to above 100 kilocycles after this calibration has been completed. The meter-scale linearity will be within 3% or 4% of full scale. If you adjust the meter needle about 2% of full scale above the zero mark with the meter-needle adjusting screw, you'll improve the linearity to 1% or 2%.

To measure amplifier gain and frequency response, connect an audio signal generator to the amplifier's input terminals. Measure the signal generator output and amplifier output with the audio vtvm. Voltage gain = amplifier output voltage divided by signal generator output voltage. Decibel gain = amplifier output decibels minus signal generator output decibels.

The same hookup is used to signal-trace a defective audio amplifier. Check the grids and plates of the tubes for the presence of a signal with the audio vtvm. To signal-trace a radio, tune the receiver to a local radio-station frequency. A demodulator probe connected in series with the audio vtvm input is used to check the rf and if stages. This probe is not required for measurements in the audio stages. END

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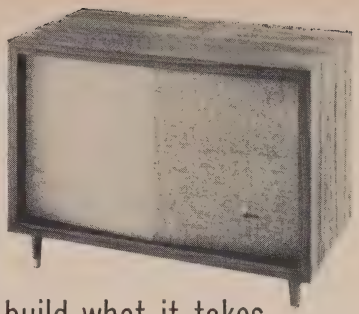

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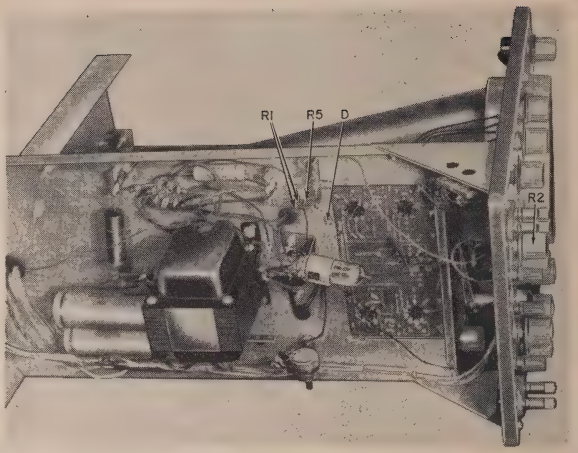


Zener-diode circuit added to a Heathkit OM-1 scope.

By PAUL S. LEDERER

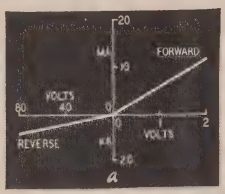
THIS circuit is based on an unusual characteristic of some types of semiconductor diodes. It delivers square waves with accurately known amplitudes, obtained by clipping the 60-cycle alternating voltage which supplies the low-voltage rectifier circuit of the oscilloscope.

The great usefulness of an amplitude calibrator in an oscilloscope is apparent to anyone who has ever used a scope. All expensive precision scopes have such a device. Inexpensive ones usually have a terminal on the panel at which either 6.3 volts rms or 1 volt peak to peak can be obtained. Such a fixed voltage has only limited use. A continuously variable voltage output from the calibrator is preferable. With it, scope deflection due to a voltage of unknown amplitude can be duplicated and its value read on the calibrator dial.

Amplitudes are usually measured on a peak-to-peak basis. While the use of a sinusoidal calibration voltage is satisfactory, a square-wave calibration signal allows more precise matching of amplitudes.

Such a square wave may be obtained in two ways. A multivibrator circuit generates very good square waves with a maximum amplitude of about 100 volts. A large number of components is needed and the added drain on the scope power supply may be excessive.

Another common method consists of clipping sine waves. The components required are smaller in number, the principal one being a rectifying diode and a source of dc bias to establish the clipping level. The dc bias poses a problem—if a battery is used (for a clipping level near 50 volts) it will either have to be replaced frequently (if it's a dry battery) or require a more expensive mercury battery. If a voltage regulator tube is used instead of a battery, extra drain is imposed on the power supply.



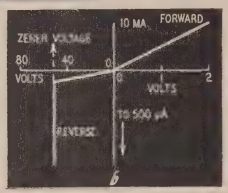
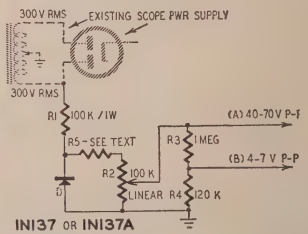


Fig. 1-a—Typical characteristic of a germanium diode, b—characteristic of a silicon junction diode.

A very simple clipped sine-wave type of voltage calibrator can be constructed using newly developed semiconductor diodes. These are silicon-junction diodes and are similar in many respects to the familiar germanium diodes, like the 1N34. However, there are significant differences which can best be illustrated by the graphs in Figs. 1-a and -b.

Fig. 1-a shows a characteristic typical of a germanium diode. When voltage is applied in the forward direction, the diode conducts heavily; for voltage in the reverse direction, the diode conducts very little (note changed scale on axis for reverse direction).

Fig. 1-b shows the characteristic of a silicon-junction diode. It is substantially like the one shown in Fig. 1-a except that in the reverse region, when a certain voltage is reached, the diode conducts *heavily in the reverse direction.* As shown by the graph, the reverse voltage across the diode will remain constant over a wide range of reverse currents. Known as Zener voltage, this makes it possible to use a silicon diode as a voltage reference element in many applications.



R1—100,000 ohms, 1 watt
R2—pot, 100,000 ohms, linear taper
R3—1 megohm, 5%
R4—120,000 ohms, 5%
R5—See text
All resistors ½ watt unless noted
D—IN137 or IN137A silicon-junction diode

Fig. 2 — Amplitude calibrator circuit.

Circuit action

The basic schematic of the voltage calibrator is shown in Fig. 2. The ac voltage from one side of the power supply winding of my scope (Heath OM-1), 300 volts rms (420 volts peak) is applied to a 100,000-ohm linear potentiometer in series with a 100,000-ohm resistor (to limit current through the diode). Thus about half the applied voltage appears across the potentiometer and diode. Let us consider the

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action of the circuit during one cycle of the ac. On the positive-going half of the cycle, since the voltage is applied to the diode in the reverse direction, this voltage appears across R2. When the positive-going voltage reaches the Zener voltage of the diode, the diode conducts in the reverse direction and the voltage across it (and consequently across R2) remains constant at the diode's Zener voltage for the remainder of the half of the cycle until the applied voltage dips below this level again. During the negative half of the applied voltage, the diode conducts heavily in the forward direction, and the voltage across it (and the potentiometer) is practically zero. Thus this circuit delivers a positive-going square wave with an amplitude determined by the diode's Zener voltage.

While the particular diode I used (1N137) may no longer be available, type 1N137A has the same characteristics. Manufacturing tolerances specify a range of Zener voltage from 40–70 for it. The value for any diode can be determined by applying dc from a variable power supply to the diode in reverse direction through a current-limiting resistor and measuring the voltage across the diode. The Zener voltage is reached when the voltage across the diode remains constant when the applied voltage is increased.

Zener voltage of the diode I used was 51. Since I wanted a maximum calibrator output of 50 volts, peak to peak, an additional resistor R5 (2,000 ohms) was inserted in series with R2 to bring the voltage across it to exactly 50. The value of R5 will depend on individual requirements determined by the Zener voltage of the diode available and desired full-scale calibrator range. To take advantage of the linearity of the potentiometer, it must be loaded with at least five times its own resistance to reduce the resulting nonlinearity to about 3%. The input resistance of the scope's vertical amplifier and the calibration range divider is about 600,000 ohms. A second full-scale range of 5 volts peak to peak is obtained across resistor R4 and scope input in parallel. The divider resistors are composition types, 5% tolerance.

When completed, bring the calibrator output voltages to new terminals mounted on the scope's front panel. To use the calibrator, connect the proper calibrator terminal (A or B) to the scope's vertical input terminal. This gives you a square wave whose height may be varied with R2. When this square wave is adjusted so that its height is the same as that of a displayed waveform, you can read the peak-to-peak voltage of the waveform from R2's calibrated dial.

Calibrating the system against the ac scale of a vtvm showed the voltage calibrator appears to be accurate well within ±10% of the value. This was considered entirely consistent with the quality of the scope and the measurements made with it. END

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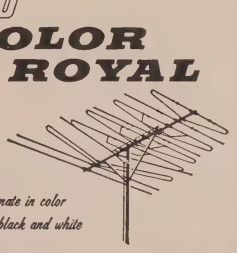

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A vtvm probe for measuring rf signal voltages without loading the circuit

High-Impedance RF probe

By FRANK H. TOOKER

RF PROBES, like that shown in Fig. 1, are excellent for making rf voltage measurements in comparatively low-impedance circuits. Poking one of them at a control grid or plate circuit of a pentode rf amplifier, however, is often the equivalent of partially shorting from that point to ground! Voltage readings obtained in a receiver under such conditions are about as accurate as those obtained when a 1,000-ohm-per-volt meter is used where a vtvm is needed. What is needed for accurate receiver designing, testing and servicing is an rf equivalent of the vtvm—a probe that can be placed at a point of high-impedance rf without materially affecting circuit operation.

The probe shown in the photos and Fig. 2 is one step in this direction. A moment's study of Fig. 2 will reveal that it is a diagram of a cathode follower coupled to a diode rectifier and has a circuit about the same as that of a conventional probe. The tube, a *6AB4*, acts as an impedance transformer. The cathode produces a low impedance to work into the shunt rectifier, while its grid is at a very high impedance (2 megohms shunted by the grid–plate capacitance plus a fraction of the grid–cathode capacitance), causing minimum loading in the circuit being measured. Of particular interest is the fact that the probe's circuit is linear within 10% up to 31 mc with at least 2 volts rms input. A larger input can be used if the tube's plate voltage is increased.

The rf voltage across cathode resistor R2 is only slightly lower than that across grid resistor R1. The probe is designed to be used with a conventional 11-megohm-input vtvm and to produce rms readings on the meter's dc scale. Therefore, the slight differences in voltages between the grid and cathode of the 6AB4 can be compensated for by proper selection of filter and multiplier resistor R3. The accuracy of the readings is somewhere around 10%—about the same as a conventional probe. The regulated power supply, shown in the Fig. 3, plus the 100% degenerative feedback of the cathode follower, gives the circuit extremely high stability. The 6AB4 was selected as a compromise between characteristics and heat generated within the probe. As it is, the probe runs barely hand-warm.

Construction details

The probe is built into a 1⅝ x 2⅛ x 2¾-inch aluminum box. Of course, tubular construction like that of conventional probes is also possible.

The probe tip is made to the dimensions given in Fig. 4, to fit over a 1-5/32-inch hole punched in one end of the box. A socket punch does this job neatly. While only the probe lead goes through it, this hole should be large, to keep stray capacitance to a minimum. The tubular center shield is removed from the 6AB4's socket. Mount the socket so the tube's grid (pin 6) will be directly opposite the center of the 1-5/32-inch hole when the two halves of the box are assembled.

Grid capacitor C1 has one lead cut very short. It is mounted toward the center of the socket and tightly against pin 6, to which it is soldered. The other lead is left long to fit up inside the probe tip. By using a couple of terminals for ground connections and a two-terminal tie point, the remainder of

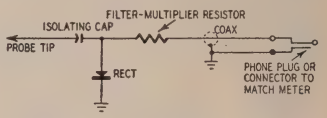
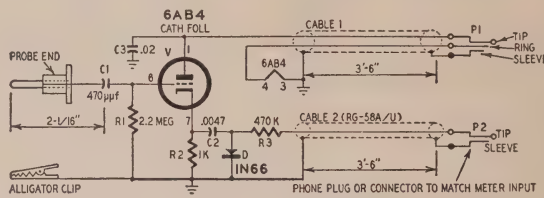


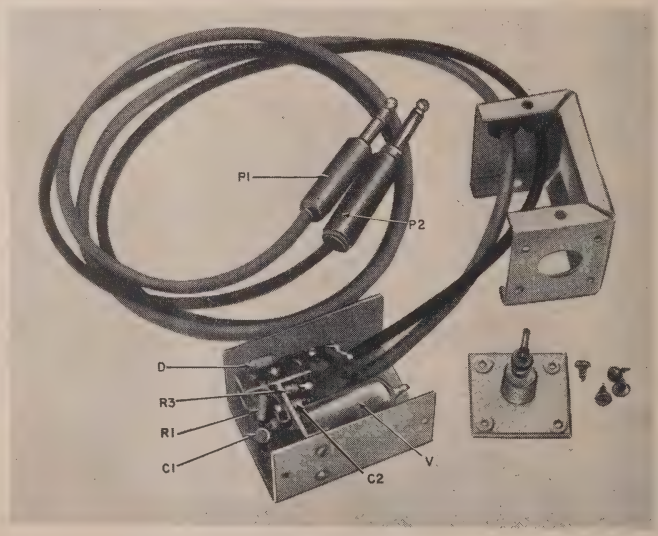
Fig. 1—Conventional rf probe.



R1—2.2 megohms, ½ watt
R2—1,000 ohms, ½ watt
R3—470,000 ohms, ½ watt
C1—470 μμf, ceramic
C2—.0047 μf, ceramic
C3—.02 μf, ceramic
D—1N66
P1—3-conductor plug (see text)
P2—2-conductor plug to match instrument input
V—6AB4
Case, 1⅝ x 2⅛ x 2¾ inches

Polystyrene, 1½ x 1½ x ⅛ inches
Polystyrene, ½-inch diameter, ⅝ inch long
Probe tip
Socket, 7-pin miniature, ceramic
Cable, 2-conductor shielded (Belden 8422 or equivalent), 3½ feet
Cable, RG-58A/U coax, 3½ feet
Alligator clip
Tinned copper braid
Miscellaneous hardware

Fig. 2—Circuit of the high-impedance rf probe.



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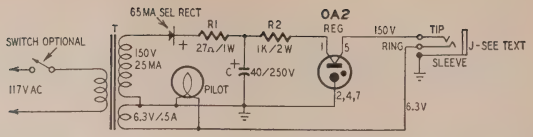
the components in the circuit can be wired in with ⅛-inch leads.

Two ⅜-inch holes are drilled in the end of the probe case opposite the 1-5/32-inch hole. These are fitted with ¼-inch (inside diameter) rubber grommets to accommodate the 3½-foot length of coax signal cable and two-conductor shielded power supply cable. Both are anchored inside the probe by bolting their shields to the side of the box. A 6-inch length of ⅛-inch tinned copper braid with an alligator clip at one end is used for the ground connector. Spread the other end of the braid slightly, tin it, drill a hole for a No. 6 screw, and install the wire under one of the self-tapping screws in the case, as shown in the photos.

The power supply

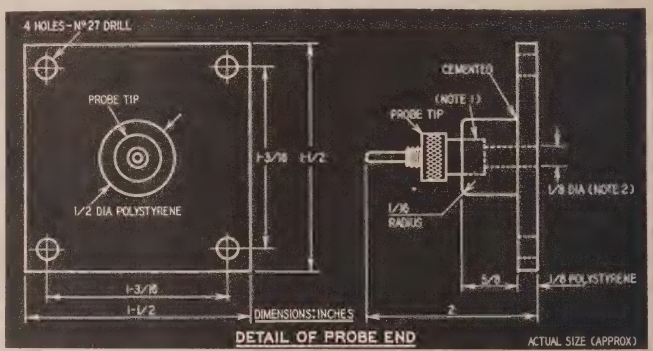
The probe's power supply, shown in the photos and Fig. 3, is conventional and easily built. It is mounted inside a 3 x 4 x 5-inch gray hammer-tone aluminum box. The jack used for the power supply connections needs a slight modification. These jacks permit a momentary short between the tip and ring contacts while the plug is being inserted. Normally, the tip contact is made to fall into the groove on the tip of the plug. Bend the tip contact of the jack outward so contact is made to the diameter of the ball of the tip when the plug is inserted. This slight change allows good contact pressure without the possibility of a short between tip and ring contacts. The modification is easy and should be made before the jack is installed in the box. Use of the jack specified in the parts list is recommended, although it is possible that other jacks of similar construction may be similarly altered. (The possibility of a short can be avoided by using twin-contact coax connectors such as JAN type UG-102/U plug and UG-103/U receptacle between the power supply and cable.—*Editor*) A 4½-inch rope cleat is fastened to the back of the power supply case. It becomes a convenient storage place for the power cord.



R1—27 ohms, 1 watt
R2—1,000 ohms, 2 watts
C—40 μf, 250 volts, electrolytic, can type
J—3-conductor phone jack (Switchcraft No. 12B) modified, see text
RECT—selenium, 65 ma, 130 volts
T—power transformer: primary, 117 volts; secondary; 150 volts, 25 ma; 6.3 volts, 0.5 ma (Merit P-3046 or equivalent)
V—0A2
Pilot-lamp assembly
Socket, 7-pin miniature
Case, 3 x 4 x 5-inches, gray hammer-tone
Miscellaneous hardware

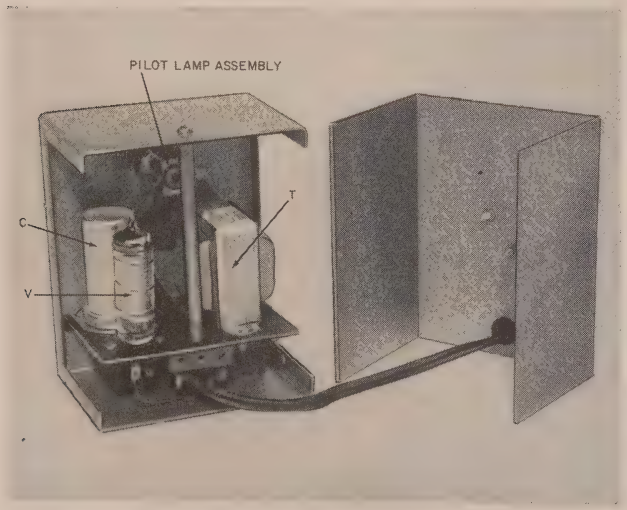
Fig. 3—Power supply for the rf probe.

Despite the tendency toward cancellation of input capacitance in the grid circuit of a cathode follower, a small amount (principally the 6AB4's grid–plate capacitance) still exists in this probe. Therefore, slight retuning is sometimes necessary when measuring high-frequency tuned circuits. The probe's sensitivity is limited by the sensitivity of the vtvm with which it is used. Multiply meter readings by 1.414 to obtain peak voltage values. END

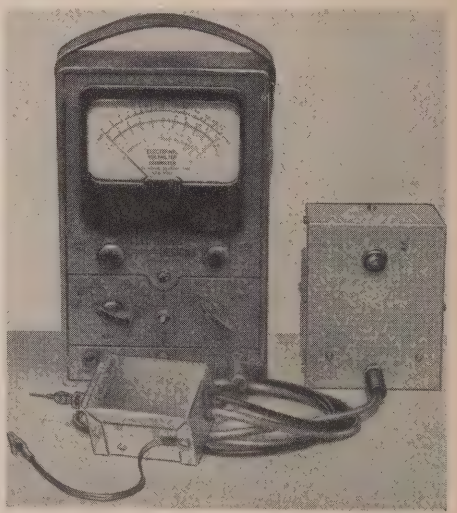


NOTES: (1) Drill hole slightly smaller than end of probe tip. Heat probe tip and press into hole. Allow to cool before disturbing.
(2) Use hand drill. Machine tools cause melting of polystrene; fouling and wandering of drill.

Fig. 4—Details of probe-tip construction.



Component layout inside the power supply.

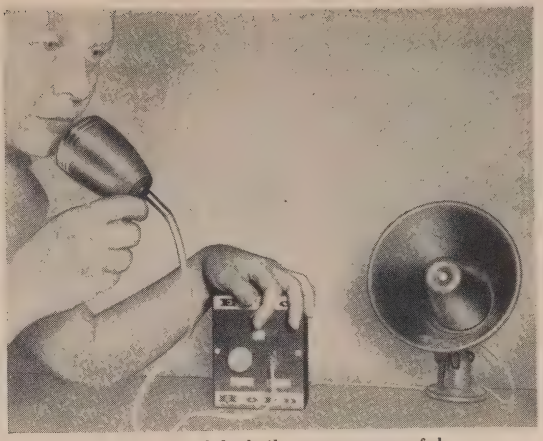


Rf probe, power supply and vtvm.

All-transistor 4-stage amplifier delivers 1 watt of audio as a penetrating warning horn or portable megaphone

ELECTRONIC BOAT HORN and HAILER

By HOMER L. DAVIDSON



A final test of the hailer proves successful.

"CLEAR the dock, we're coming in for a landing," shouted the boat operator. Yes, this article deals with a small all-transistor combination boat horn and amplifier. The horn is actually a feedback squeal obtained by coupling the output circuit to the input. A crystal microphone is switched into the circuit for the amplifier.

This is a four-stage job, with a 2N255 power transistor (V4) driving the speaker. The 2N255 is inexpensive and delivers about 1 watt to a metal-cone speaker. This transistor's collector is connected to its case, which is bolted to the chassis. All common ground (positive) connections are made above ground on insulated terminal strips. The mike jack must also be insulated from the metal chassis.

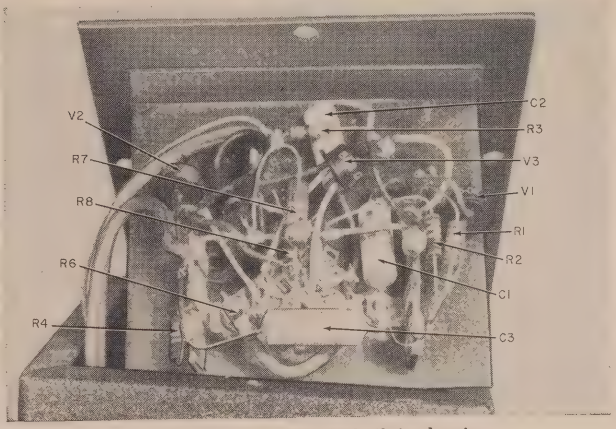
Circuit details

A 5-μf electrolytic capacitor couples the microphone jack to V1's base. A momentary-contact telephone type switch in V1's output circuit switches in the amplifier or boat horn. Another 5-μf capacitor couples the signal to a 10,000-ohm volume control (R5). This control does two jobs. When using the amplifier, it regulates the signal level applied to V2. In the horn circuit, R5 varies the feedback to V2's base, which varies the horn's tone.

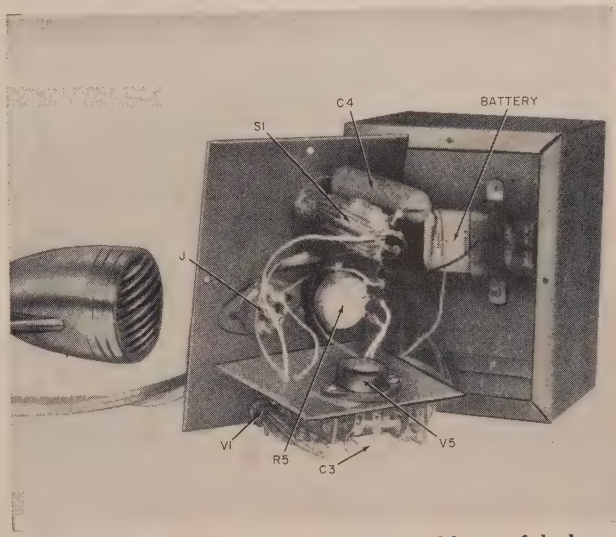
A University MIL 45-ohm speaker is used in V4's output circuit. Its voice coil matches the 2N255's output impedance, doing away with the output transformer.

Assembling the horn

I used a small metal case with a built-in chassis to house the electronic horn. The power transistor is mounted close to the chassis' rear and plugged into a nine-prong miniature tube socket. The chassis acts as a heat sink, although it isn't really necessary as the unit is used only for brief periods. A dpdt telephone type switch is mounted on the front panel and wired so that, when it is pushed down, the horn sounds. The 6-volt battery is fastened to the back panel of the case and wired directly into the circuit. Terminal strips and the unused socket terminal act as



Layout of parts under the built-in chassis.



A look behind the front panel shows the suggested layout of the larger components.

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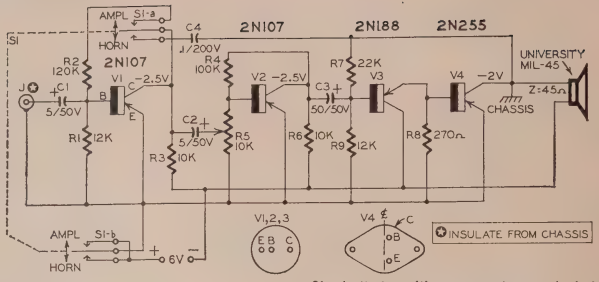
ELECTRONICS



R1, 9—12,000 ohms
R2—120,000 ohms
R3, 6—10,000 ohms
R4—100,000 ohms
R5—pot, 10,000 ohms, audio taper
R7—22,000 ohms
R8—270 ohms
All resistors 1/2-watt 10%
C1, 2—5 μf, 50 volts, miniature electrolytics
C3—50 μf, 50 volts, miniature electrolytic
C4—0.1 μf, 200 volts
J—phono jack
SI—dpdt, 3 positions momentary contact, telephone type switch (Switchcraft 13036 or 3036 or equivalent)
V1, 2—2N107 (G-E)
V3—2N188 (G-E)
V4—2N255 (CBS)
Battery, 6 volts (Eveready 724 or equivalent)
Case, 4 x 5 x 3 inches with built-in chassis
Speaker, 45-ohm voice coil (University MIL-45 or equivalent)
Miscellaneous hardware

Circuit of the simple four-transistor device.

tiepoints for the resistors, capacitors and other transistors.

There are a couple of precautions you must observe. Avoid overheating the transistors while soldering. Do not insert V4 into its socket until all wiring is completed. When you wire V1, V2 and V3 into the circuit, keep a pair of long-nose pliers between the end of their leads and the case. Keep leads from shorting against the chassis by using short lengths of spaghetti as necessary.

Final tests

After you are finished assembling the unit, check the circuit two or three times for correctness. One of the best checks is to take a voltmeter and make sure that battery polarity is correct. Incorrect polarity caused by a reversed battery can ruin the transistors.

When you are sure everything is OK, press down on the switch. An audible tone will be heard. Now vary the volume control and the tone's pitch will change. A lower note is better for a warning signal.

The amplifier section can be checked by hooking up a crystal mike to jack J and pushing the switch upward. Or you can plug a record player into the jack and listen to the results.

Many times I have been stranded out on the lake with some kind of motor trouble and watched other boats whiz past. With this type of horn, the sound will travel large distances to attract attention. The horn can also be used to help avoid a collision when fast speedboats are cruising in your path. I can also remember evenings when I've used the horn to warn people who do not have lights on their boats or have them turned off. The amplifier provides a handy way of calling to someone in another boat or when the landing dock is crowded with people and you want to bring your boat into the dock. END

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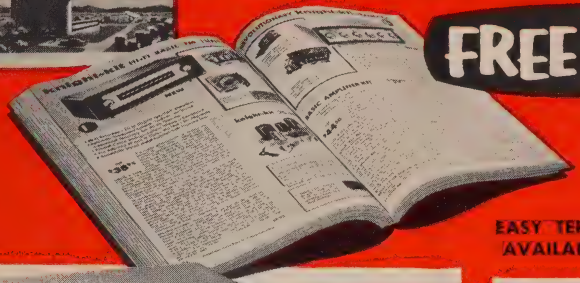

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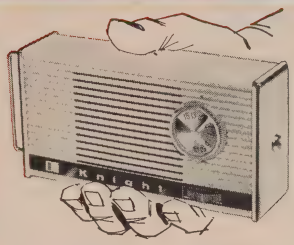

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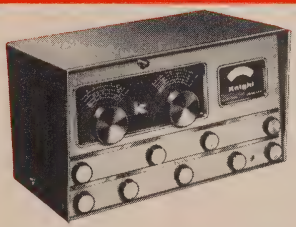

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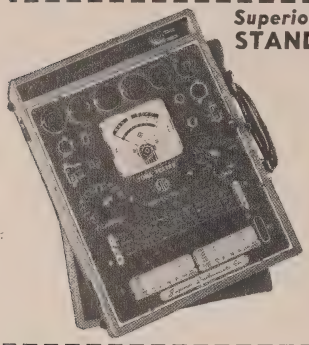

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TRANSISTOR and HYBRID DC AMPLIFIERS

Two simple amplifiers increase relay sensitivity thousands of times. The all-transistor unit has low impedance, current-excited input; hybrid unit has high-impedance, voltage-driven input

By BERT J. HILL*

MANY scientific instruments depend upon dc amplifiers. These are often chopper-stabilized vacuum-tube units which are relatively large and expensive. And while choppers are of definite value, they do require periodic replacement. To avoid using choppers we looked to all-transistor and hybrid dc amplifiers.

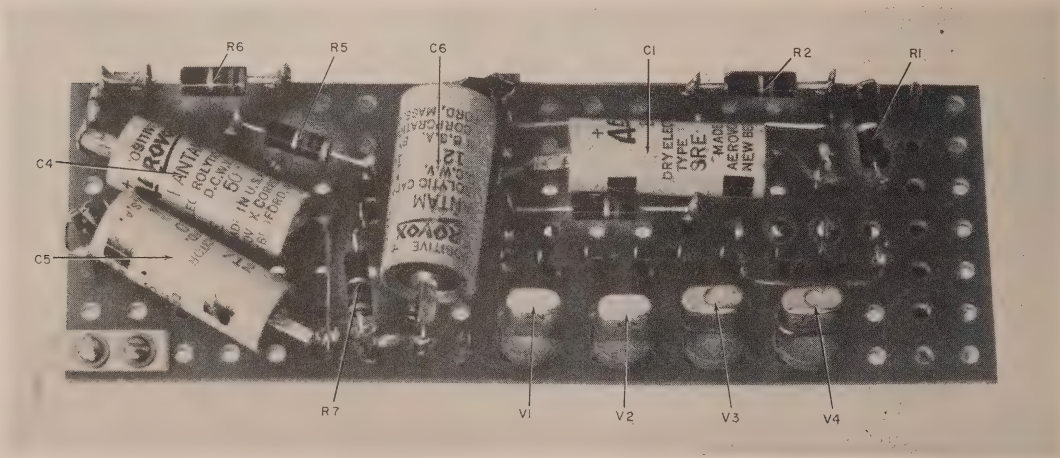
We wanted a dc amplifier which could amplify a fraction of a milliampere several thousand times so the original signal could trigger a relay with a pull-in current of several ma. Size had to be kept down and temperature sensitivity eliminated. Also, the input impedance had to be low, since the unit would be primarily a current-measuring device connected in series with an external circuit using platinum and gold indicator electrodes. Any voltage applied to the external circuit would adversely affect the electrode balance of the instrument. Therefore, no bias or feedback could be used in the amplifier's first stage.

The first amplifier we came up with, which has been in use since early 1957, is a three-stage all-transistor unit. Its circuit is shown in Fig. 1. The first stage (V1, V2) is similar to the balanced input used in vacuum-tube circuitry. Note that base current is in the reverse direction through one of the input transistors so the input impedance is increased considerably. This did not materially affect the instrument's operation, since we were dealing with a signal of a fraction of a microampere. If a lower impedance is desired, the signal should be passed through just one transistor with the ground connection reconnected to the common emitter point of the two input transistors. The base of the other input transistor should be returned to ground through a 1-megohm resistor. This input arrangement may prove helpful if you desire to use this circuit for signals of higher current in which a low-impedance input would be required.

V3 and V4 form typical common-emitter stages. Potentiometer R3 is used to balance V1 and V2 and provides the second-stage V3 with the proper bias. The bias is set so that current through the relay with no signal was 0.5 ma. An input signal of 0.5 μa increases output current to more than 4 ma, closing the relay and operating the required control unit. The unit's current gain of 8,000 is more than enough for our needs.

The balanced input stage was selected to counter temperature changes. It

*Research Dept., Central Scientific Co., Chicago, Ill.



One side of the chassis in the dc amplifier shown in Fig. 1. The unmarked resistor is R4.

is simple and the problem of matching transistors for V1 and V2 is easily handled. With 1.5 volts applied to the collector and the base open, we measured collector current. Transistors with about the same collector currents are accepted as matched. This balanced stage takes care of temperature changes so that we get satisfactory operation with a "cold" instrument as well as one which has been in operation for many hours.

Our amplifier is exposed to severe ac fields and relatively large capacitors are used. The large time constant is not disadvantageous when working with dc variation with a slow rate of change. Under less severe conditions smaller capacitors could be used and in some places they might be eliminated.

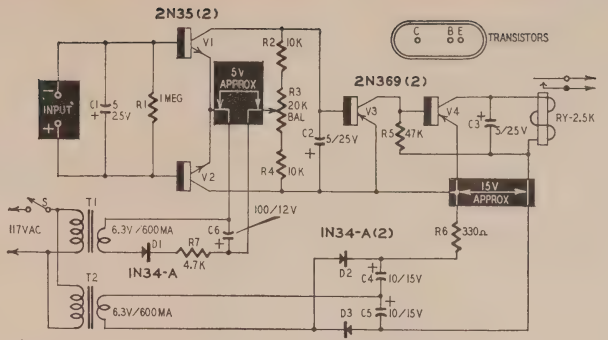
The amplifier is powered by batteries or a small ac supply. Circuit design requires two voltage sources.

A hybrid amplifier

A second type of amplifier—a hybrid—is shown in Fig. 2. It uses a 12AX7 in a balanced input stage and two common-emitter transistor stages. This amplifier gave excellent results and since it presents a high impedance to the external circuit, is especially useful where small voltage changes are to be measured without loading the circuit. An input of 5 mv increases output current more than 4 ma. Shunt the input with an appropriate resistor and it can be used as a current-actuated device.

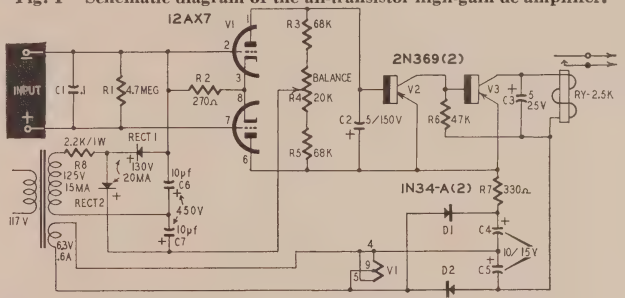
We did not try to make either amplifier linear as they key a relay and are not used in calibrated measuring devices.

Although the units are simple, they do a good job with no need for voltage stabilization, feedback circuits or special temperature-compensation networks. The experimenter should find many applications for both units. END



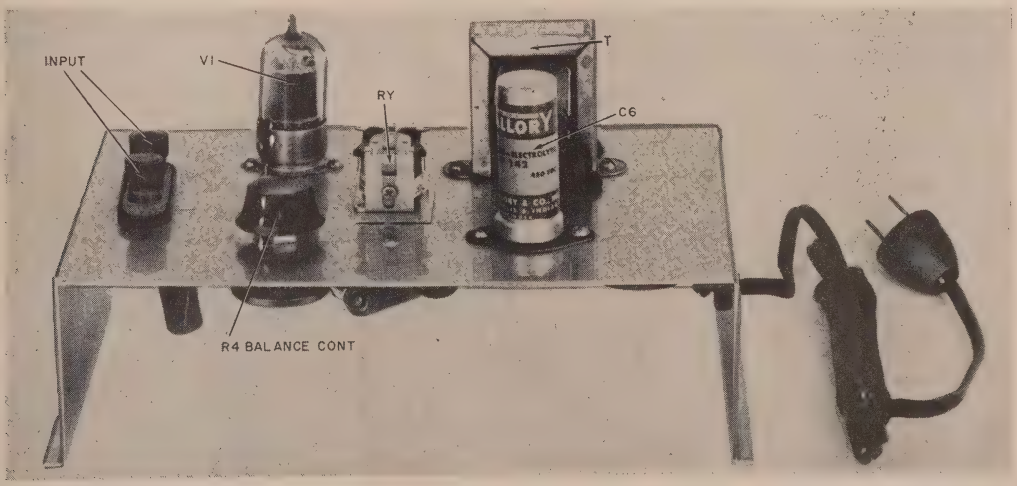
R1—1 megohm
R2, 4—10,000 ohms
R3—pot, 20,000 ohms
R5—47,000 ohms
R6—330 ohms
R7—4,700 ohms
All resistors ½-watt 10%
C1, 2, 3—5 μf, 25 volts, electrolytic
C4, 5—10 μf, 15 volts, electrolytic
C6—100 μf, 12 volts, electrolytic
D1, 2—IN34-A (G-E)
RY—2,500-ohm coil, closes on 4 ma or less (Sigma 4F-2500 or equivalent)
S—spst switch
T1, 2—heater transformers: primary, 117 volts; secondary, 6.3 volts, 600 ma (Triad F-13X or equivalent)
V1, 2—2N35 (Sylvania)
V3, 4—2N369 (Texas Instruments)
Chassis, to suit
Miscellaneous hardware

Fig. 1—Schematic diagram of the all-transistor high-gain dc amplifier.



R1—4.7 megohms
R2—270 ohms
R3, 5—68,000 ohms
R4—pot, 20,000 ohms
R6—47,000 ohms
R7—330 ohms
All resistors ½-watt 10%
C1—0.1 μf, 200 volts
C2—5 μf, 150 volts, electrolytic
C3—5 μf, 25 volts, electrolytic
C4, 5—10 μf, 15 volts, electrolytic
D1, 2—IN34-A (G-E)
RY—2,500-ohm coil, closes on 4 ma or less (Sigma 4F-2500 or equivalent)
V1—12AX7
V2, 3—2N369 (Texas Instruments)
Chassis, to suit
Power supply delivering 250 volts dc at 10 ma and 6.3 volts at 300 ma
Miscellaneous hardware

Fig. 2—A hybrid version of Fig. 1, using a tube and two transistors.



A view of the high-gain tube–transistor amplifier in Fig. 2.

COMMUNICATIONS via METEOR BURSTS

Meteors and modern techniques combine to give longer-range two-way communications in the 30–100-mc band

By G. FRANKLIN MONTGOMERY

DURING the early Forties, when the FM broadcast service was operating in its old band at 42 to 50 mc, Federal Communications Commission monitoring engineers discovered a strange effect. Short bursts of signal were received occasionally from FM stations as far as 1,370 miles away. This distance was much greater than the 100 miles or so considered maximum line-of-sight. The signal bursts were brief, usually lasting for less than a second. They showed none of the characteristics associated with known abnormal propagation such as ionospheric sporadic-E transmission or atmospheric bending.

After a careful study, E. W. Allen, Jr.[1] identified the bursts with individual meteors, the small outer-space particles of matter that plunge into the atmosphere by the billions each day. This intermittent vhf propagation over intermediate distances has led to some unusual developments.

Meteor bursts are signal reflections from the atmospheric ionization that these high-speed particles produce. Ranging in size from almost microscopic grains to an occasional mass of rock or iron weighing several tons, meteors enter the atmosphere at velocities as great as 40 miles per second. At an altitude of about 60 miles, their friction with the thin atmosphere produces temperatures high enough to melt and vaporize the meteor and to split molecules of the air into ions and free electrons.

In the meteor's wake, a miniature ionosphere is formed in the shape of a slender, slowly expanding cylinder, perhaps several miles in length. The ions and electrons produced by this process eventually recombine to form neutral gas molecules, but it may take many seconds for them to do so.

Early experiments

After the war, to study meteor behavior, a number of experimenters began measuring radio reflections from meteor trails with vhf radar equipment. About 1950, the idea occurred almost simultaneously to several engineers that meteors might provide useful radio communication from one point to another. Shortly thereafter, groups at the Defence Research Telecommunications Establishment (Canada), the National Bureau of Standards, the Stanford Research Institute and RCA Laboratories began work to develop regular communication by this means.[2] Amateurs in the US also began work with similar techniques.[3]

Suppose we have two stations, A and B, about 1,000 miles apart. Each station has a transmitter and receiver with antennas beamed toward a patch of sky (about 60 miles up) that can be seen from both stations. Each transmitter radiates a carrier wave continuously. Receiver A is tuned to transmitter B, receiver B to transmitter A. (Transmitter frequencies must differ slightly so transmitter A will not interfere with receiver A, nor transmitter B with receiver B.) Ordinarily, each station receives only a very weak signal or none at all. But from time to time, a meteor will pass through the part of the atmosphere included in the antenna beams of both stations. As it does so, it produces a trail of ionization. If this trail is oriented properly with respect to the stations, both will receive a signal burst that may last from less than 1/10 second to many seconds before it fades into the background noise.

Fig. 1 shows the kind of variation that is typical of separate meteor bursts. In addition to the main outlines of an abrupt rise and slow decay in signal amplitude, subsidiary fading is often observed on some bursts. The fading is attributed to breakup of the trail by high-altitude atmospheric winds.

Speeded-up transmission

Stations A and B can communicate with each other during these brief intervals. With ordinary equipment, however, communication is difficult or impossible with the signal lasting for so short a time. Modern information-handling techniques now come into play. If A is to send a message to B, the message can be stored at A in record form—on magnetic drums or tape, for example. When a signal burst occurs at A, the recorded message is played back at high speed and modulates A's transmitter. The same high-speed message at the output of B's receiver is recorded at B. Subsequently, when the signal burst has passed, B's record is played back at normal speed so that the message can be understood.

This general procedure is the basis for burst communication. Storing information at normal speed, playback and transmission at high speed, reception and recording at high speed, and playback at normal speed are common to all systems now in development. Teletypewriter, voice and even facsimile modulation have been used successfully in meteor-burst experiments. Usually the goal is two-way communication, with both stations transmitting and receiving different messages simultaneously, using the same signal burst. This end has already been achieved with teletypewriter messages sent at up to 40 times the normal speed of 60 words per minute.

In addition to the recording equipment, control circuits are required at each station to perform certain functions automatically. When a burst is received, there must be a threshold device to judge whether the signal amplitude of the burst is large enough

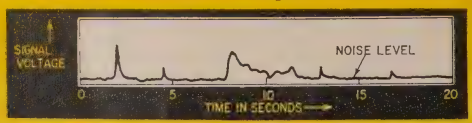


Fig. 1—Sketch of typical meteor-burst signals shows amplitude and duration of received information.

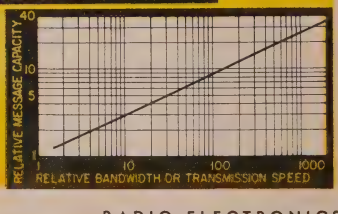
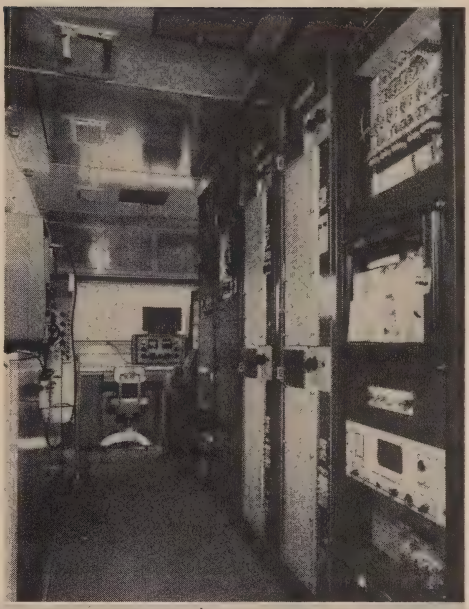


Fig. 2—Message capacity plotted against bandwidth or transmission speed.

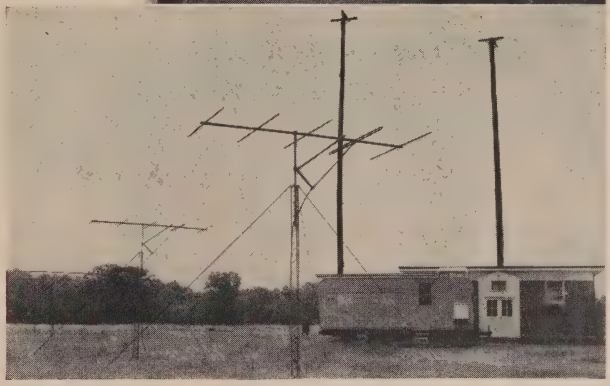
to warrant starting transmission. If it is, the high-speed record and playback units must be signaled to start. When the received burst amplitude falls below a preset threshold, these units must be stopped, and so on. In a two-way system, it is almost certain that the received signals at both stations will not behave in exactly the same manner. A code of check signals is often sent around the loop from one station to the other and back before starting transmission from either. This procedure may sound like a waste of precious transmitting time, but it is done within a few milliseconds and greatly reduces the possibility of transmission errors.

Fundamental to any communication system is the signal-to-noise ratio at the receiver while the message is in progress. If the message is sent more rapidly than normal, the receiver bandwidth must be increased to avoid message distortion. An increased receiver bandwidth admits more noise, which in itself may distort the message. In conventional systems where communication is continuous, a compromise must therefore be made between speed of transmission and degradation of the received signal-to-noise ratio.



Interior of trailer. Two racks to the rear contain receiving and control equipment. Two central racks are magnetic tape storage, record and playback units for transmitting and receiving. Tape is stored in vertical perforated metal tanks. Foremost rack contains monitoring equipment.

(Below) Experimental meteor-burst communication station. Four Yagi antennas are arranged in double arrays for transmitting and receiving. Radio and terminal equipment are housed in trailer to the rear.



Courtesy National Bureau of Standards

Long or short; large or small?

In a meteor-burst system, where communication is intermittent, this compromise has unique consequences. The signal bursts in such a system vary widely in amplitude and duration. A few bursts have very large peak amplitudes; many more have small amplitudes. A particular burst of any amplitude may be short, or it may last for a relatively long time. The bursts can be predicted only statistically. Whether the next burst will be large or small and exactly when it will occur are both matters of chance.

Now, in setting up a system, we may choose to operate only with the few bursts of large amplitude and transmit at high speed. Alternatively, we may use the many bursts of smaller amplitude, as well as the large ones, and transmit slowly.

The striking feature of meteor-burst statistics is that it pays to use only the large bursts. The price that must be paid for using them effectively is transmission speed and bandwidth. In addition, a longer wait is required between transmissions, although this waiting period may be unimportant in some applications.

The faster we are prepared to transmit and record during a burst, and the fewer bursts we use, the greater the message capacity of the system. (A convenient measure of message capacity is the total length of message that can be sent over the system in a period of time long enough to include a large number of bursts.) Fig. 2 illustrates this dependence. Relative message capacity and relative bandwidth or transmission speed are plotted using logarithmic scales. The capacity is not directly proportional to the bandwidth but increases more slowly. In a typical case, it is proportional to the bandwidth or speed raised to about the 0.4 power.

The choice of operating parameters for a meteor-burst system is made more difficult by the erratic nature of the bursts. Their random occurrence and amplitudes would not be particularly troublesome if we could depend upon known average occurrence rates and average amplitudes. But we cannot.

We do know that a typical system of moderate power may operate with four or five 1-second bursts per minute on the average. Throughout the day, however, the actual number of bursts per minute changes from a high rate in the pre-dawn hours to a low rate at sunset. The total number of bursts varies from day to day.

At any given time, there is a best section of sky toward which the antenna beams should be pointed to intercept the greatest number of useful trails. The position of this best section also changes throughout the day and probably with the seasons. All these meteor-burst characteristics have been measured extensively, but they must be known even more exactly to achieve the best communication performance.

Forward-scatter competition

In one sense, meteor-burst systems[4] are competitors with ionospheric forward-scatter systems. Both provide communication over the same distances in the same part of the vhf spectrum, roughly 30–100 mc. However, meteor-burst systems may be able to use higher frequencies than are profitable for ionospheric scatter.

One distinct advantage of meteor bursts is the lower power required. Most experimental work has been done with transmitter powers from 100 watts to a few kilowatts. Operational scatter

systems usually require tens of kilowatts and high-gain antennas. While high-gain antennas are certainly useful for meteor-burst work, satisfactory results have been obtained with simple Yagis of moderate gain. The principal disadvantage, of course, is the complex message-handling equipment needed at the terminals. Perhaps this disadvantage will seem less severe after more experience with these devices.

The high frequencies (3 to 30 mc), which we depend on for both intermediate- and long-distance communication, have been badly crowded for many years. During ionospheric storms, high-frequency communication is often unreliable. Even so, there is little hope that future technical improvements will provide space for all of the services that would like to use this part of the spectrum. The situation is rather like an overcrowded bus with more riders than seats. Those standing must either ride uncomfortably until someone abandons a seat, or give up the idea of riding altogether. Meteor-burst communication, it is hoped, will provide a larger bus. The hope is bright enough that much effort is being spent on its development. END

References

[1] E. W. Allen, Jr., "Reflections of Very-High-Frequency Radio Waves from Meteoric Ionization," *Proceedings of the IRE*, Vol. 36, No. 3, pages 346–352; March, 1948.

[2] Meteor-burst Communication Papers, *Proceedings of the pages IRE*, Vol. 45, No. 12 pages 1642–1736; December, 1957.

[3] "ARRL Merit Award for 1955 Goes to W4HHK and W2UK," *QST*, Vol. 40, No. 10, page 62; October, 1956.

[4] Scatter Propagation Issue, *Proceedings of the IRE*, Vol. 43, No. 10, pages 1173–1526; October, 1955.

VOICES OF THE SATELLITES

Believed to be the only commercially available recording of the radio signals from Sputnik I and II and Explorer I, II and III, *Voices of the Satellites* is the work of Prof. Thomas A. Benham of Haverford College, Haverford, Pa. The signals were recorded with a specially built convertor–amplifier. Professor Benham, who is totally blind, also produces a nonprofit science magazine on tape, *Science for the Blind*, which issues 400 recordings per month. His satellite recording, available on a 5-inch tape reel or 10-inch LP record, is distributed by Taben Recordings, Box G-224, Ardmore, Pa. ($3.95).

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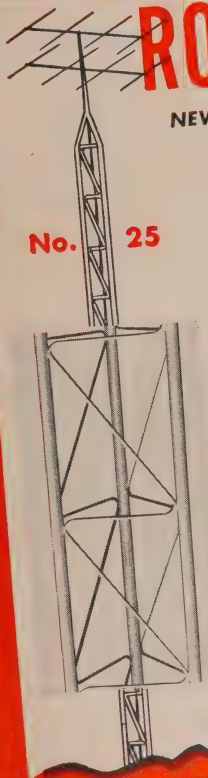

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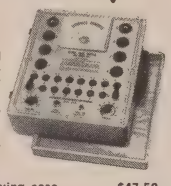

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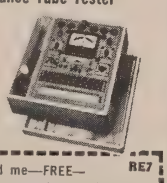

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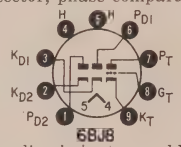
New Tubes & Semiconductors

THIS month's releases are highlighted by a switching transistor that can also be used in audio circuits, some high-voltage silicon rectifiers and a versatile tube that can serve many purposes in a TV receiver.

6BJ8

This twin-diode medium-mu triode is intended for use in a wide variety of monochrome and color TV receiver circuits. The diode units are useful in phase detector, phase comparator, ratio



detector or discriminator, and horizontal afc discriminator circuits. The triode section is suited for phase-splitter, audio amplifier, low-frequency oscillator and vertical-deflection amplifier circuits. The 9-pin miniature tube has a 6.3-volt 600-ma heater with a controlled warmup time.

Maximum ratings of this RCA tube are:

Triode unit as Class-A1 amplifier:	
V_P	300
V_G (pos bias value)	0
I_K (average) (ma)	20
Plate dissipation (watts)	3.5
Peak heater–cathode voltage (htr neg with respect to cath)	200
(htr pos with respect to cath)	200
Diode units:	
I_P (dc) (ma)	9
I (peak) (ma)	54

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☐ 100 – KNOB SPRINGS standard size ⅜" x ½"..$1
☐ 100 – ASSORTED KNOB SET-SCREWS.....$1
☐ 25 – ASSORTED CLOCK RADIO KNOBS.....$1
☐ 400 – ASST. H'DWARE screws, nuts, rivets, etc..$1
☐ 50 – ASST. SOCKETS octal, noval and miniature..$1
☐ 20 – ASSORTED TUBE SHIELDS best sizes.....$1
☐ 50 – ASST. MICA CONDENSERS some in 5%..$1
☐ 50 – ASST. CERAMIC CONDENSERS.....$1
☐ 10 – ASST. VOLUME CONTROLS less switch....$1
☐ 5 – ASST. VOLUME CONTROLS with switch ...$1
☐ 100 – VOLUME CONTROL HEX NUTS.....$1
☐ 20 – ASST. PILOT LIGHTS popular types.....$1
☐ 10 – PILOT LIGHT SKTS. bayonet type, wired...$1
☐ 50 – ASST. TERMINAL STRIPS 1, 2, 3, 4 lug ..$1
☐ 10 – ASST. RADIO ELECTRO. CONDENSERS.$1
☐ 5 – ASST. TV ELECTROLYTIC CONDENSERS.$1
☐ 15 – ASST. TV COILS sync. peaking, width, etc. .$1
☐ 10 – RCA COIL FORMS ⅞" x 3" many purposes .$1
☐ 25 – ASST. MICA TRIMMER CONDENSERS..$1
☐ 50 – TUBULAR CONDENSERS .001–600v.....$1
☐ 15 – TUBULAR CONDENSERS .047–600v $1
☐ 50 – TUBULAR CONDENSERS .01–400v.....$1
☐ 2 – ELECTROLYTIC COND. 40/40–450V.....$1
☐ 2 – ELECTROLYTIC COND. 40/10/10–450v...$1
☐ 30 – FP CONDENSER MOUNTING WAFERS..$1
☐ 3 – ELECTROLYTIC COND. 80–450v.....$1
☐ 3 – ELECTROLYTIC COND. 50/30–150v $1
☐ 15 – TUBULAR CONDENSERS .015–1600v.....$1
☐ 10 – HV TUBULAR CONDENSERS .006–1600v..$1
☐ 10 – HV TUBULAR CONDENSERS .001–6000v..$1
☐ 10 – HV TUBULAR CONDENSERS .005–6000v..$1
☐ 35 – MICA COND. 20–100 mmf & 15–270 mmf.....$1
☐ 35 – MICA COND. 20–470 mmf & 15–680 mmf.....$1
☐ 35 – MICA COND. 20–820 mmf & 15–1000 mmf $1
☐ 35 – CERAMIC COND. 20–5 mmf & 15–10 mmf.....$1
☐ 35 – CERAMIC COND. 20–25 mmf & 15–47 mmf...$1
☐ 35 – CERAMIC COND. 20–56 mmf & 15–82 mmf ..$1
☐ 35 – CERAMIC COND. 20–100 mmf & 15–150 mmf..$1
☐ 35 – CERAMIC COND. 20–270 mmf & 15–470 mmf..$1
☐ 35 – CERAMIC COND. 20–1000 mmf & 15–1500 mmf..$1
☐ 35 – CERAMIC COND. 20–2000 mmf & 15–5000 mmf..$1
☐ 50 – 100Ω ½ WATT RESISTORS 5%.....$1
☐ 75 – 470KΩ ½ WATT RESISTORS 10%.....$1
☐ 50 – 470KΩ 1 WATT RESISTORS 10%.....$1
☐ 25 – 100KΩ 2 WATT RESISTORS 10%.....$1
☐ 10 – ASST. WIREW'ND RES. 5, 10, 20 watts...$1
☐ 3 – AUDIO OUTPUT TRANS. 50L6 type $1
☐ 3 – AUDIO OUTPUT TRANS. 6K6 or 6V6 type...$1
☐ 3 – I.F. COIL TRANSFORMERS 456 kc.....$1
☐ 3 – I.F. COIL TRANSFORMERS 10.7 mc FM ...$1
☐ 4 – OVAL LOOP ANTENNAS asst'd hi-gain types .$1
☐ 3 – LOOPSTICK ANT. new ferrite adjustable.....$1
☐ 12 – RADIO OSCILLATOR COILS 456 kc.....$1
☐ 3 – ½ MEG VOLUME CONTROLS with switch ..$1
☐ 5 – 50K VOLUME CONTROLS less switch.....$1
☐ 10 – SURE GRIP ALLIGATOR CLIPS.....$1
☐ 1 – GOLD GRILLE CLOTH 14"x14" or 12"x18"..$1
☐ 1 – 5" PM SPEAKER alnico #5 magnet.....$1
☐ 5 – SETS SPEAKER PLUGS wired $1
☐ 10 – SETS PHONO PLUGS and PIN JACKS..$1
☐ 2 – $2.50 SAPPHIRE NEEDLES 4000 playings...$1
☐ 5 – DIODE CRYSTALS 2–1N21 2–1N23 1–1N64 ..$1
☐ 2 – SELENIUM RECTIFIERS 1–65 ma & 1–150 ma $1
☐ 1 – TV VERT. OUTPUT TRANS. 10 to 1 ratio ..$1
☐ 5 – TV CRT. SOCKETS with 18" leads $1
☐ 5 – HI-VOLT. ANODE LEADS with 18" leads....$1
☐ 1 – TV RATIO DETECTOR TRANS. 4.5 mc.....$1
☐ 1 – SET TV KNOBS standard type incl. decals $1
☐ 1 – LB SPOOL ROSIN CORE SOLDER 40/60...$1
☐ 6 – SPIN TIGHT SOCKET SET 3/16" to 7/16"..$1
☐ 3 – TV ALIGNMENT TOOLS 5", 7", 12".....$1
☐ $15 – "JACKPOT" TELEVISION PARTS.....$1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

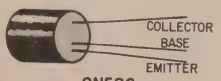
ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

BROOKS RADIO & TV CORP.

84 Vesey St. Dept. A, New York 7 N.Y.

2N586

A germanium p-n-p alloy-junction transistor designed for use in low-speed switching applications in industrial and military equipment. It is particularly useful as a relay-actuating device and in voltage-regulator, multivibrator, dc-



2N586

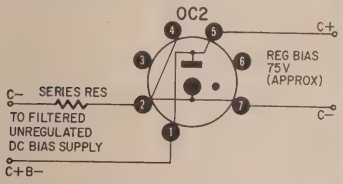
to-dc converter, and power supply circuits. It may also be used in audio oscillator service and in large-signal class-A or class-B push-pull audio-frequency amplifier service.

Tentative maximum ratings in switching service of this RCA transistor are:

V_{CB}		−45
V_{EB}		−12
I_C (ma)		−250
I_E (ma)		250
P_c (mw)	(25°C)	250
	(55°C)	125
	(71°C)	60

0C2

A cold-cathode glow-discharge voltage-regulator tube using a seven-pin miniature envelope. It is intended for use in voltage-regulator applications where a relatively constant dc output voltage is required across a load, independent of moderate line-voltage varia-

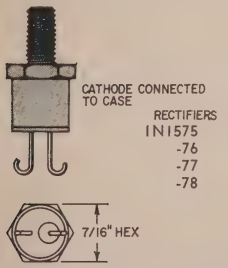


tions. In the circuit shown the RCA 0C2 will supply a regulated output of approximately 75 volts at cathode currents within the range of 5–30 ma.

In the circuit enough series resistance to limit the operating current through the tube to 30 ma at all times after the starting period is vital. Note, too, that socket connections are made so that the voltage on the load is removed when the tube is taken from its socket.

IN1575, IN1576, IN1577, IN1578

Stud-mounted, diffused-junction silicon rectifiers designed to handle much larger surge currents than other silicon



rectifiers with comparable continuous ratings. The cathode is connected to the case.

FIRST TIME AT VIBRATOR PRICES:

MORE RELIABILITY!
MORE EFFICIENCY!
LONGER LIFE!
CLEANER OUTPUT!

transistorized

UNIVISTORS

Replace troublesome vibrators mount-to-mount

Really dependable mobile power is now yours in seconds simply by plugging a transistorized Univistor vibrator substitute into the vibrator socket. The superiority of transistorized power, quality engineered by Universal, the pioneer in transistorized power components, brings you efficiency and reliability unheard of in today's conventional electro-mechanical vibrators priced as much as 50% LESS THAN COMPETING BRANDS!

The Univistor converts your power supply into a modern **all-electronic** supply, eliminating moving parts and, consequently, eliminating repeated vibrator maintenance and replacements. The Univistor's operating-life is more than 20 times that of a vibrator. It eliminates electrical and mechanical noise—provides cleaner output throughout its entire life. You make one larger unit sale knowing you'll avoid those unprofitable call backs, while your customer gets longer, trouble-free service which more than pays for its cost. Life-to-life, the Univistor actually costs less than a vibrator.

There are no wiring or circuit changes required. Univistors are available with bases corresponding to commercially available vibrators. Since the two germanium power transistors comprising the amplifying elements of the system are independent of the power transformer action, the Univistor may also be interchanged as a separate component in power inverters and converters. In addition, the Univistor can not be damaged by input polarity reversal.

The next time you replace a vibrator—and you must—you'll supply exceptional dependability and efficiency and profit more, too, with Transistorized Univistors! See your Universal distributor or write:

UAC Electronics
A DIVISION OF
UNIVERSAL TRANSISTOR PRODUCTS CORP.
DEPT. R7 17 BROOKLYN AVE., WESTBURY, L.I., N.Y., EDGEWOOD 3-3304

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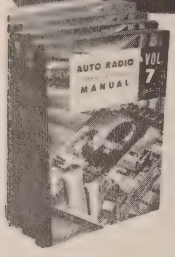
SHOW YOU HOW!



Most complete auto radio service data available: Schematics, voltages, resistance readings, alignment, chassis photo views keyed to components, replacement parts recommendations—everything you need to know for quicker, easier servicing. Each volume, 8½ x 11".

AR-7. Covers 56 auto radio models produced in 1957. Only.....**$3.75**

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AR-5. Covers 96 models produced during 1954-55. Only.....**$3.50**

AR-4. Covers 61 models produced during 1953. Only.....**$3.00**

AR-3. Covers 83 models produced during 1950-52. Only.....**$3.00**

AR-2. Covers 73 models produced in 1949-50. Only.....**$3.00**

GET EXTRA HELP WITH

SAMS "AUTO RADIO REMOVAL" MANUALS

Solves the toughest problem in auto radio servicing—shows fastest ways to remove radio, power supply and speaker units. Covers all standard and sports model cars. 5½ x 8½".

ARR-57. Covers all 1957 cars.
ARR-56. Covers all 1956 cars.
ARR-55. Covers all 1955 cars.
Each Volume, only.....**$2.95**

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Send me book(s) checked at right for 10 days FREE examination. In 10 days I will pay for the book(s), plus a few cents delivery cost, or return postpaid.

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☐ AR-6 ☐ AR-2
☐ AR-5 ☐ ARR-57
☐ AR-4 ☐ ARR-56
☐ ARR-55

Name_____

Address_____

City_____ Zone____ State_____

(Outside U.S.A. priced slightly higher)

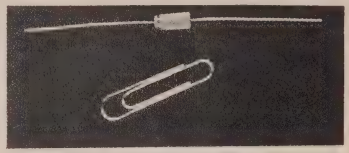
NEW TUBES & SEMICONDUCTORS *(Cont'd)*

Maximum ratings of these Motorola rectifiers are:

	1N1575	*-76*	*-77*	*-78*
PIV	100	200	300	400
RMS input (sine wave)	71	141	212	283
Half-wave rectified forward current at 25°C (amps)	3.5	3.5	3.5	3.5
Peak ½ cycle forward current (60 cycles, 25°C) (amps)	70	70	70	70
Peak recurrent forward current (60 cycles, 25°C) (amps)	10	10	10	10

CX7A1H

A miniaturized copper-oxide diode for low-voltage low-current applications in control, instrument, computer and pulsing circuits. Announced by Bradley Laboratories Inc., the unit is insulated by a nylon tube housing through which leads are inserted.



Specifications for instrument use are: continuous-duty current rating, 2 ma; ac input, 6 volts rms maximum; peak inverse of 8.5 volts maximum. For other applications, the current value can be increased 5 times and voltage value doubled. Maximum temperature rating is 85°C. END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In July, 1908, *Modern Electrics*

Modern Electric Tubes, by H. Gernsback.

The Ceraunograph, by the Rev P. J. Philippe, S.J.

A New Detector (Oxyde of Titanium).

The Speaking Arc Lamp, by V. H. Laughter.

Telephotography, by the Berlin Correspondent.

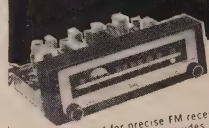
The Talking Condenser, by H. G. Hugo.

How to Make a Complete 2-Mile Wireless Station, by H. Henry.

Wireless Without Aerial, by Elliott Blood.

Marconi's Method for Sustaining Oscillations.

ARKAY STEREO HI-FI KITS AND PREWIRED

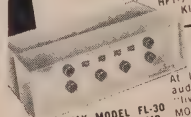


ARKAY FM-8A
Professional Standard FM TUNER

Engineered for precise FM reception Arkay "Miracle Ear" Sensitivity provides 1.9 uV for 20 db quieting. Freq. Response 20-20,000 cps. Outstanding features include 3 tuned RF stages, dual limiters, Armstrong FM Foster Seeley discriminator, variable AFC, Silent tuning system, tuning meter, cathode follower, high level & Binaural FM (multiplex) outputs. 0-100 log scale for station pinpointing, self-contained AC power supply plus many other extras.

KIT $39.95 **WIRED $59.95**

ARKAY AM-5 AM TUNER Most sensitive AM tuner "Miracle Ear" 2 uv for 20 db s/n Wide & Narrow Band 3 gang tuning cond. 10Kc whistle filter
KIT $23.45 WIRED $35.95
HFT-7 AM-FM Tuner AFC, Sensitive...
KIT $32.00 WIRED $49.95



ARKAY MODEL FL-30 HI-FI AMP PRE-AMP
An engineering masterpiece TRANSISTORIZED front end assures finest in Hi-Fi sound. Freq response ½ db 10-40,000 cps 30 watts, 50 watt peak inputs for magnetic pickup, tuner, tape & 2 aux. Complete with step-by-step plans, handsome black cabinet & rose gold panel.
KIT $49.95
WIRED..... $74.95

ARKAY STEREO AT SENSIBLE PRICES!
At last the economical audiophile can enjoy "living sound"
MODEL SA-25—Just attach your present amp to this dual channel preamp & 25 watt amp
KIT $59.95
WIRED $89.95
MODEL SP-6 Dual channel pre-amp with cathode follower
KIT $46.90
WIRED $62.95
MODEL ST-11—Binaural-stereo tuner highly sensitive AM & FM reception.
KIT **$49.95**
WIRED **$74.50**

SEE N'HEAR THESE ARKAY UNITS!

Arkay FL-10—12 watt amp pre-amp—only $29.95

Arkay A-12—Amp pre-amp for budget-minded. Output 12 watts. Easily assembled $22.95

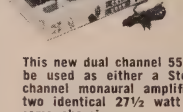
Arkay FL-5—5 watt amp gives true hi-fi performance kit for beginner $12.25

Arkay BI2-High Efficiency Speaker System Kit 17x17½x15 5/16". Simple. Nail, glue and stain $12.95. Model B-12S with Co-ax spkr. and Bal. $25.00

Arkay TR-6—All-transistor port superhet kit, output better 275 mil watts 540-1620 kc. Superb tone. Const extremely simple $33.95

Arkay TR-5 Personal Portable—5 transistor, printed circuit printed layout component bd. assembled 3 hr. High impact styrene case. jack for pvt. listening $29.95

NEW!



Arkay Stereo Dual Channel 55 Watt Amp SPA-55

This new dual channel 55 watt amplifier can be used as either a Stereo or as a dual channel monaural amplifier. It consists of two identical 27½ watt amplifiers on the same chassis.....$79.95
Save! Easy-to-build Kit $64.95

arkay
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FREE! Reg. 35c Book "Let's Talk About STEREO"-Available at Your Dealer's, yours for the asking-No Obligations.

Technicians' News

WARRANTY POLICIES HIT

A strongly worded resolution condemning the warranty policies of some television, radio and high-fidelity set manufacturers as "another captive service" was approved by the Federation of Radio & Television Servicemen's Associations of Pennsylvania (FRTSAP). Forty delegates from 15 chapters, meeting at Ephrata, Pa., blasted receiver producers whose warranties have the effect of "footballing free labor and service for periods up to 1 year."

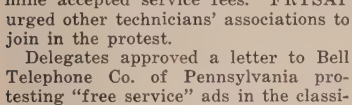
The resolution was aimed at set makers who offer "free parts and labor" warranties and fix the fees to be paid to service technicians for repairs made under them. The resolution stated that this practice "threatens to undermine accepted service fees." FRTSAP urged other technicians' associations to join in the protest.

Delegates approved a letter to Bell Telephone Co. of Pennsylvania protesting "free service" ads in the classified directories as bait advertising.

Milan Krupa, of Wilkes-Barre, was named to head a committee to investigate the possibility of co-sponsoring "Radio Repair Month" next year with the Pennsylvania Association of Broadcasters as a substitute for the annual "Radio Month."

NEW ESFETA OFFICERS

Robert Larsen (second from right), of Valley Stream, L. I., was elected president of the Empire State Federation of Electronic Technicians Associa-



tions (ESFETA) at the annual meeting in Binghamton, N. Y. Other officers (left to right): George Carlson, Jamestown; Irving J. Toner, East Aurora, vice president; Frank Kurowski, New Hartford, sergeant-at-arms; Dan Hurley, Syracuse, treasurer.

REPAIR RACKET CHARGED

New York State authorities took action to dissolve a TV service company which they said had defrauded its customers of $1,000,000 in the last 5 years. Attorney General Louis J. Lefkowitz was authorized by State Supreme Court Justice Thomas A. Aurelio to begin action to revoke the charter of Eagle Radio & Television Service, Inc., of Bronx, N. Y.

The Attorney General said his in-

Just 2 settings on the NEW

Model FC-2

FAST-CHECK TUBE TESTER

tests over 600 tube types completely, accurately ... AND IN SECONDS!

SIZE: H: 11¼" W: 14⅜" D: 4⅜"

• NO MULTIPLE SWITCHING
• NO ROLL CHART CHECKING

NEW Special compartment to accommodate line cord and CRT Test Adapter cable

The FAST-CHECK enables you to save valuable time and eliminate unprofitable call backs. You earn extra money and win confidence by showing your customer the actual condition and life expectancy of the tube on the large meter scale of the FC-2. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

CANNOT BECOME OBSOLETE

Engineered to accommodate all future tube types...new tube listings furnished periodically.

TRY THE FC-2 BEFORE YOU BUY IT!

Shipped on approval for FREE 10 day trial ... No obligation to buy

EASY TO BUY IF YOU'RE SATISFIED!

Pay in small monthly payments at net cash prices... no financing charges

MODEL FC-2—housed in rugged oak carrying case complete with CRT adapter, tube listings ..... only $69.50 Net

GUARANTEED FOR 1 FULL YEAR

This extremely low price is made possible only because YOU ARE BUYING DIRECT FROM THE MANUFACTURER

WIDE RANGE OF OPERATION

- Checks quality of over 600 tube types ... more than 99% of all TV and radio tubes, including the newest series-string TV tubes, auto 12 plate-volt tubes, OZ4s, magic eye tubes and gas regulators.
- Checks inter-element shorts and leakage.
- Checks for gas content.
- Checks for life expectancy.

IMPORTANT FEATURES

✓ Checks each section of multi-section tubes and even if only one section is defective the tube will read "Bad" ✓ 41 long lasting phosphor-bronze tube sockets accommodate all present and future tube types—cannot become obsolete ✓ Less than 10 seconds required to test any tube ✓ Large D'Arsonval type meter is extremely sensitive yet rugged—is fully protected against accidental burn-out ✓ Line isolated ✓ 7-pin and 9-pin straighteners conveniently mounted on panel ✓ Quick reference tube chart lists over 600 tube types ✓ Line voltage compensation

NEW A specially designed PICTURE TUBE ADAPTER cable is now part of the FC-2 ... making it a highly efficient CRT Tester-Rejuvenator. This feature eliminates the need of carrying extra instruments and makes the FC-2 truly an all-around tube tester. The adapter enables you to check all picture tubes (including the new short-neck 110 degree picture tubes) for cathode emission, shorts and life expectancy .... also to rejuvenate and restore cathode emission of weak picture tubes.

WHAT SERVICEMEN* are SAYING ABOUT THE FC-2

"You've really made tube testing a snap" ... "I've almost got the cost of the Fast-Check paid off with the extra money I've made, and it's only 2 weeks since I received it" ... "It's easier to use than you said" ... "I wouldn't ever want to be without it" ... "I use it in the shop and take it along on every call".

*Names on request

MAIL COUPON NOW—NO MONEY REQUIRED WITH ORDER

CENTURY ELECTRONICS CO., INC. 111 Roosevelt Avenue Dept. 107 Mineola, N.Y.

Please rush the new Model FC-2 FAST-CHECK TUBE TESTER for a 10 day trial period. If I am not completely satisfied I will return the instrument within 10 days without further obligation. If fully satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. No financing charges are to be added. Should I fail to make payment when due, the unpaid balance shall become due and payable at once.

☐ BUDGET TERMS: Pay $14.50 within 10 days after receipt of instrument. Balance $11.00 monthly for 5 months, plus shipping charges.

☐ PREPAID TERMS: Enclose $69.50 with coupon as payment in full and Century will pay all shipping costs. 10 day money-back guarantee.

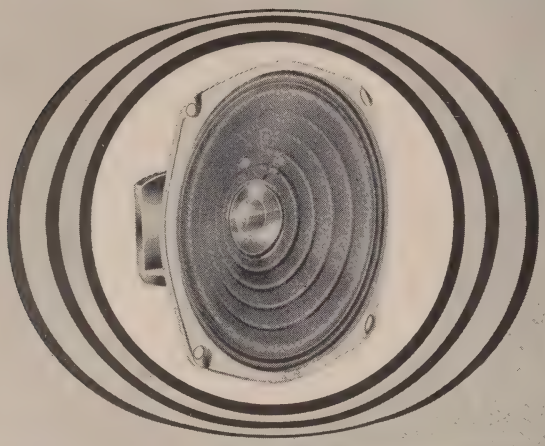
Name.....

Address.....

City..... State.....

ABSOLUTELY NO RISK ON YOUR PART

For protection against heat, humidity or dust—wherever operating conditions are severe—



the installation is safe with QUAM SPEAKERS featuring the exclusive HUMI-GARD CONE

This new Quam exclusive, the Humi-Gard Cone, is a plastic-impregnated synthetic fiber fabric cone that has the response characteristics of an untreated paper cone—yet will outlast treated paper cones at least three to one! Not only is it weather-resistant but abrasion-resistant as well! Whenever a TV set or communications system is subject to extreme conditions of humidity, dust or similar situations harmful to speakers, a Quam speaker with a Humi-Gard Cone is the perfect solution. The Humi-Gard Cone is available in speakers up to 6½".

Only in Quam speakers do you get the famous patented Adjust-a-Cone Suspension and U-Shaped Pot, and the new exclusive Humi-Gard Cone.

Write for your free copy of Catalog S-757, describing the complete line of Quam Public Address, Outdoor and Intercom speakers.

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QUAM-NICHOLS COMPANY

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D. Eldon McLennan, Ltd., 1624 W. Third Avenue, Vancouver 9, B.C.

Send for it today!

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Precision, battery-operated transistorized portable

TAPE RECORDER

Weighs only 2 lbs. 8"x7"x2"
(imported from West Germany)

Precision-engineered—Records, plays back, erases. Variable speed controls. Operates on 4 ordinary C-batteries. Uses standard ¼" 1-mil or ½-mil tape. Playback time about 15 min. Patented motor mount provides for forward and reverse winding; stopping with instantaneous braking action, taking up all slack tape; preventing tape from spilling. Voice can be dubbed and superimposed on music or other voice recording (and vice versa). Fine, durable, high-quality components. Complete instructions.
Servicemen—Dealers! Every service call an easy sale after a simple demonstration. Renders same functions as machines costing many times as much.

Your cost for sample, only **$29.95.** Suggested retail selling price, $39.95! On your reorder for two or more, earn an additional 10% discount. Hurry—be the first in your area with this sure-fire item! Everyone will buy! Rush order now!

Unconditionally guaranteed for 90 days against mechanical defects. 10-day money-back guarantee.

FILNOR PRODUCTS CO. Dept. RE-7 **1 Park Ave., N.Y. 16, N. Y.**

vestigation showed that the company had advertised over the radio that it would repair TV sets on credit with no down payment and nothing to pay until 30 days after completion of the work, when customers would pay 50¢ a week. Actually, he stated, often no estimate was given and the customer was notified repairs had been made and he could retrieve his set by paying $15 to $35 and the balance in $5 instalments. He said that most customers were told they needed new picture tubes costing $30 to $40, that the charges were often excessive and often the sets failed to work properly after repairs.

PAY TV OPPOSED

A resolution stating that pay TV is not in the best interest of television or the independent service technician was approved by the membership of Associated Radio–Television Service Dealers (ARTSD), Columbus, Ohio, and forwarded to Congressman John Vorys and to the Columbus City Council. ARTSD also approved a proposal by Don Wilson that all local TV and radio stations be made associate members with no dues obligations.

Bob Kapp, Mercury TV, was named to the board of directors; Herman Francis was appointed chairman of the ethics committee; Bob Hawthorne, Hawthorne TV, chairman of the technical and educational committee.

LICENSING UPHELD

The constitutionality of Detroit's television technician licensing ordinance has been upheld by Circuit Judge Horace W. Gilmore, who dismissed a suit brought by William Murphy, owner of Murphy's Radio & TV Service, Detroit. Murphy had refused to apply for a license, contending the law violated the Federal and state constitutions by unlawfully delegating legislative powers to an administrative board.

NATESA ADDS AFFILIATES

The National Alliance of Television & Electronic Service Associations (NATESA) opened its doors to all state technicians' groups through an amendment to the constitution at its directors' meeting in Springfield, Mo. The directors accepted 14 new organizations into membership, bringing the total of NATESA affiliates to 98.

NATESA's Friends of Service Management Awards were presented to Sylvania, CBS, Sprague Electric Co., Howard W. Sams & Co. and P. R. Mallory & Co. The technical program was highlighted by demonstrations by Winston Starks of Winston Electronics and Norm Peterson of Kingston Electronics. George Crossland of G-E's tube division spoke on customer relations.

Nearly 200 technicians, representing 51 associations from 21 states, attended the session, which covered such issues as captive service, licensing, emblems, membership extension, wholesale abuses, trade schools, adverse publicity and the NATESA advertising and publicity program.

THIS DISPLAY WILL SELL

PICTURE TUBES FOR YOU

IT'S BIG, 19" x 23½"

IN FULL COLOR

Dr. T. V. SPARK SAYS...

YOU can check your own picture tube

YOU NEED A DEPENDABLE NEW SILVER VISION PICTURE TUBE...

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Get this PA-215 Display Card FREE from your CBS-Hytron distributor

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Discaps are packed 5-of-a-kind on a handy 3"x5" file-card. Knockout panels on the back of the package let you remove one capacitor at a time without disturbing the others or destroying the package.

Mallory-RMC Discaps are made by the world's largest manufacturer of ceramic disc capacitors—are available in popular ratings. You can depend on Discaps for the most critical applications.

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• Capacitors • Vibrators • Resistors • Controls • Switches • Filters • Rectifiers
• Power Supplies • Mercury and Zinc-Carbon Batteries

The board revealed plans for the biggest convention in NATESA's history Aug. 21–24 at Chicago's Congress Hotel, and invited all service technicians, including nonmembers.

The social program was highlighted by fishing and airplane trips over the Ozarks, a visit to the nationally televised Country Music Jubilee program and entertainment. Door prizes were supplied by Springfield area jobbers. And, notes our NATESA correspondent, "Joe Driscoll of St. Paul finally wound up the thing by winning the door!"

NEW YORK GROUP ELECTS

Robert Cornell was elected president of Certified Electronic Technicians Association (CETA) at a business meeting held at the New York Trade School. Other officers chosen were: John Hendricks, vice president; Nick Colon, Jr., treasurer; Charles Baines, recording secretary; Alfred Schabhuttl, corresponding secretary; Graham Holzhausen, sergeant-at-arms.

CETA, which is open to technicians who have completed the advanced TV techniques course sponsored by Electronic Industries Association (formerly RETMA), is currently sponsoring a series of lectures on transistors by EIA instructors. Among CETA's other recent activities was a technical lecture on automatic fine tuning and other new TV features by a group of Westinghouse representatives, who used the New York Trade School's newly installed closed-circuit system for their demonstrations.

MICHIGAN ELECTIONS

New officers of regional Michigan technicians' associations, as reported by the Alliance of Michigan Electronic Technicians Associations, Inc. (AMETA):

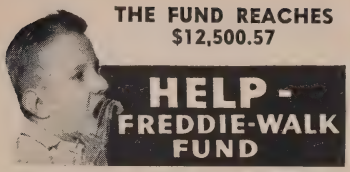
South Oakland County Television Association—Sam Baldwin, B & G Television, president; John Hengel, Hengel Radio, vice president; John Palmer, Birmingham Television, secretary; Harold Ingalls, Dequingre Radio, treasurer.

Radio Television Association (RTA) of Kalamazoo—Maurice McClish, president; Russell Reynolds, vice president; William G. West, secretary; Harry Reynolds, treasurer; Cliff Bennett, public relations director.

Tri-County Television Service Dealers Association, Benton Harbor—William Toth, president; Robert Wiley, vice president; Ray Blackburn, recording secretary; Jim Clupper, corresponding secretary; Ed Roscher, treasurer.

DAYTON'S "DOG" EXCHANGE

The Television & Electronic Service Association (TESA) of Dayton has inaugurated an exchange service for obsolete tubes and other stock. Each member has been requested to prepare a list of items he wishes to dispose of, and the lists will be circulated to other members—with the hope of eliminating the necessity of placing special orders for old and hard-to-get items. END



We regret to note that during the first six months of 1958, contributions to the Help-Freddie-Walk Fund have fallen off considerably. However, they are still coming in, and, since the fund was started in June, 1950, we have collected the grand total of $12,500 for little Freddie Thomason, the armless and legless son of a radio technician of Magnolia, Ark.

As we go to press, Freddie has just celebrated his 10th birthday, and although we have had no word from his parents for many months, we are certain that he is entering his 11th year as confidently as he has previous years.

We know that these days it is often difficult to spare money for donations, no matter how worthy the cause, and we wish to take this opportunity to thank all those who have sent in their contributions during the past months. We would also like to say a special "thank you" to John Van Dam Smith of Port Washington, N.Y., for his donation of $20, and to the Meridian TV Service for their continuing monthly contributions.

Won't you send in your donation whenever you can? No amount is too small to receive acknowledgement and the sincere thanks of all of us here at RADIO ELECTRONICS as well as Freddie's grateful parents. *Make out checks, money orders, etc., to the Kiwanis Club of Magnolia, Ark.* Send all donations to:

Help-Freddie-Walk Fund
c/o RADIO ELECTRONICS
154 West 14 Street
New York 11, New York

RADIO-ELECTRONICS Contributions as of Nov. 11, 1957	**$11,833.97**
FAMILY CIRCLE Contributions	**602.50**
Anonymous, Chambly, Quebec, Canada	**1.00**
Bourell Radio-TV Service, Steele, Mo.	**1.00**
Fred M. Brenner, Dayton, Ohio	**2.00**
E. T. Jones, RCA, Camden, N.J.	**3.00**
Mary Krull, Passaic, N.J.	**5.00**
Meridian TV Service, Washington, D.C.	**30.00**
Alexander Rys, Minneapolis, Minn.	**.10**
John Van Dam Smith, Port Washington, N.Y.	**20.00**
Mr. & Mrs. W. Brewster Snow II, Newport, R.I.	**1.00**
Peter Zwaryck, Dedham, Mass.	**1.00**
TOTAL CONTRIBUTIONS as of May 6, 1958	**$12,500.57**

SCIENCE EXPLORERS POST

The first Science Explorers post, to be devoted exclusively to scientific pursuits and officially chartered by the Boy Scouts of America, is located at Newport Beach, Calif.

The unit, made up of 28 members of high school age, is called Helipot, Science Explorers Post 201 for the sponsoring Helipot Div. of Beckman Instruments Inc.

Members of the new group have started a variety of individual technical problems ranging from the construction of a small-scale cyclotron to solid-state diffusion research.

Buy Mallory "Gems" in the new self-service Five-Pack

Mallory "Gem" capacitors now come in a convenient Five-Pack which has a sliding transparent cover that lets you remove exactly the number of capacitors you need, slides back in place to keep your spare "Gems" dust-free, with lead wires undamaged. You always know exactly how many capacitors of what values you have on hand. You can hang the "Gem" Five-Pack over your work bench within easy reach . . . ready for use.

Mallory "Gems" give you extra-cost features without premium price: • *Locked-in leads* can't loosen or open when pulled, even under soldering iron heat. • "*True center*" construction prevents premature failure. • *Moisture-proof* case of a high grade mica-filled bakelite gives real protection against humidity.

Use Mallory "Gems" for every by-pass, filter or buffer application. Get them today from your Mallory distributor.

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all-steel file cabinets
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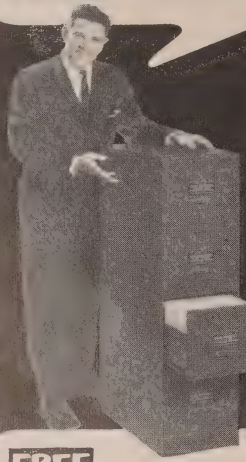
the world's finest TV-Radio Service Data



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You get FREE File Cabinets as you complete your profit-building PHOTOFACT Library... What's more, you can own the PHOTOFACT Library the new Easy-Buy way. Here's how...

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No interest. No carrying charge. As little as $10 down. Up to 24 months to pay. And Howard W. Sams will give you *absolutely free* all the steel file cabinets you'll need for your Library: Single-Drawer File Cabinet worth $8.95 with your purchase of 60 Sets of PHOTOFACT Folders; Two single-drawer File Cabinets worth $17.90 with your purchase of 120 Sets; Three single-drawer File Cabinets worth $26.85 with your purchase of 180 Sets; Four single-drawer File Cabinets worth $35.80 with your purchase of 240 Sets.

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Address.....

City.....Zone.....State.....

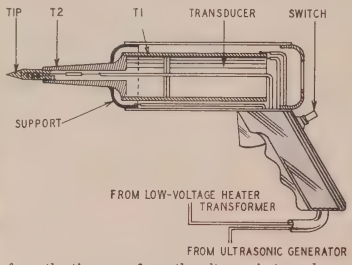
Patents

ULTRASONIC SOLDERING

Patent No. 2,815,430

Mortimer E. Weiss, Flushing, N. Y. (Assigned to Gulton Industries, Inc., Metuchen, N. J.)

Aluminum and certain other metals cannot be soldered because of an oxide film that forms on their surface. To solder efficiently, it is necessary to break down this film while applying heat. This invention uses an ultrasonic vibrator to break down the film. It includes a way of keeping heat



from the tip away from the ultrasonic transducer to prevent damage.

The transducer vibrates longitudinally at about 20 kc when energized. These vibrations are transmitted through a "velocity transformer" (T1, T2). Because of T2's smaller diameter, the original velocity is multiplied before reaching the tip. T2 is made of poor heat-conducting metal to isolate the tip from the transducer. Furthermore, a flange support shunts much of the heat to the outer metal housing, which is perforated.

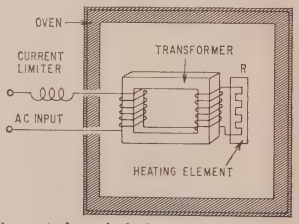
The soldering tip has its own heating element.

TEMPERATURE CONTROL

Patent No. 2,825,868

Everett O. Olsen, Wrentham, Mass. (Assigned to Foxboro Co., Foxboro, Mass.)

The Curie point, a property of nickel, cobalt and iron alloys, is the temperature at which ferromagnetism disappears, and may vary from 150° to over 2,000°, depending upon the material. For example, the Curie point of nickel is 662°.



This control method depends upon the Curie point.

The diagram shows an oven containing a transformer and heating element R. The primary is fed through a current-limiting coil. When power is switched on, ac normally appears across the secondary due to the magnetic core. However, as the core temperature approaches its Curie point, the flux drops substantially and less power flows into the heater. As the core cools, power rises again, and so on.

Oven temperature will stabilize and remain constant somewhat below the Curie point of the transformer core.

END

IT FIGURES!

My shop with work is overflowing;
Outside a bitter wind is blowing.
My next call will be again a
Call to install a new antenna!

—Phyllis Barlow

"NOISE" BIG 3

Beware Of Cheap Substitutes!

NO-NOISE NEW RUBBER COAT SPRAY

- Insulates where applied
- Protects indefinitely
- Prevents arcing, shorting, corrosion
- Waterproofs thoroughly
- Non-inflammable
- Contains no plastic

6 Oz. Spray Can Net To Servicemen **$3.25**

NO-NOISE VOLUME CONTROL and CONTACT RESTORER

- Cleans
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- Lubricates

NOT A CARBON TET SOLUTION

2 Oz. Bottle Net To Servicemen **$1.00**

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NO-NOISE TUNER-TONIC With PERMA-FILM

- Economical—a little does a lot!
- Cleans, lubricates, restores all tuners, including wafer type.
- Non-toxic, non-inflammable.
- Use for TV, radio and FM

6 Oz. Aerosol Can Net To Servicemen **$3.25**

ELECTRONIC CHEMICAL CORP.
813 Communipaw Avenue Jersey City 4, N. J.

"A Serviceman's Service"

ALL MODEL TELEVISION TUNERS REPAIRED

$8.00 plus necessary tubes and parts

5-DAY SERVICE after receipt. 90-Day Warranty on parts and workmanship.

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The same combination of coupon, scissors and a few minutes have started thousands of ambitious young men on the CREI way toward Electronics career success. Let them do the same for you. We send you a newly-printed, fact-packed book, "Your Future In The New World of Electronics," which gives you the whole story, tells you how to prepare for high pay, security, satisfaction, and the good things of life. Don't put it off. Do it right now.

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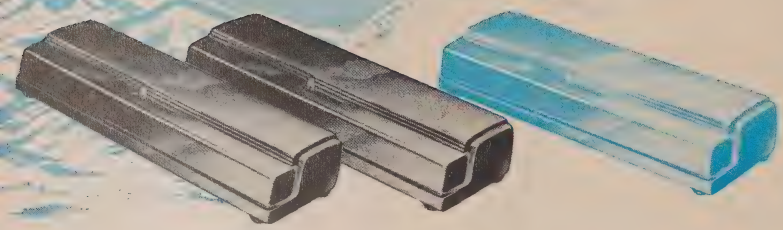
SPECIAL!



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Or buy 4 and receive 2 free with an extra "special" discount! Under either plan, you can't afford to miss the extra profits of this "Summer Vi-Fi Special"!

Vi-Fi is the *only* indoor antenna that has the modern, slim lines of the new tv sets. Vi-Fi is the *only* indoor antenna with transformer coupling and variable inductors for sharp pictures. Vi-Fi is always a good buy; this "Summer Special" makes it the biggest antenna bargain ever!

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Technotes

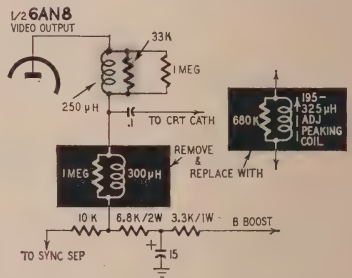
SPURIOUS BLUE LINES

Occasionally you will see spurious blue lines in a converged crosshatch pattern. These lines are relatively dim, not as bright as the regular blue lines of the pattern. They also tend to curve about somewhat arbitrarily.

These blue lines are observed in receivers where only the red and green guns are blanked during horizontal retrace. Some receivers do not blank the blue gun because of its relatively low brightness level. Thus, the spurious blue lines are not caused by the crosshatch generator, but are the result of a particular type of receiver circuit design.—*Robert G. Middleton*

OLYMPIC 14TD30

The owner was pleased except that he desired better fine detail. To achieve it I replaced the 300-μh peaking coil in the video amplifier's plate circuit with an adjustable unit so it could be tuned for sharpest detail. The original unit was shunted by a 1-megohm damping



resistor. The replacement unit is a Meissener 10-1922 which has a range of 195–325 μh. Due to the new coil's iron core, the shunt resistor was changed to 680,000 ohms. Adjusting the coil while watching the picture considerably improved detail.—*James A. McRoberts*

OSCILLATION IN RADIOS

Frequently, when aligning the if stage of a superheterodyne receiver, oscillation crops up when the first and second if transformers are tuned to resonance on the intermediate frequency. Usually the if transformers are slightly detuned to overcome this oscillation.

I have found that connecting a small resistor (½-watt 5,600–12,000 ohms) between the if transformer's secondary and the grid of the following if tube prevents oscillation and the if transformers can now be exactly tuned. This results in improved sensitivity, stability and audio.

BUILD 16 RADIO CIRCUITS AT HOME

with the New Deluxe 1958 PROGRESSIVE RADIO "EDU-KIT"

A COMPLETE RADIO COURSE

only $22.95

Reg. U.S. Pat. Off.

Now Also Includes

- ★ TRANSMITTER
- ★ SIGNAL TRACER
- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ EXCELLENT BACKGROUND FOR TV
- ★ School Inquiries Invited
- ★ Attractively Gift Packed

NO NEED TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for Television.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of $22.95. The Signal Tracer alone is worth more than the price of the entire Kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

A COMPLETE RADIO COURSE—NOTHING ELSE TO BUY

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, wire, solder, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis; special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive all parts, tools, instructions, etc. There is nothing else to buy. Everything is yours to keep.

FREE EXTRAS

- **SET OF TOOLS**
- SOLDERING IRON
- ELECTRONICS TESTER
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE
- QUIZZES
- TELEVISION BOOK
- RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE
- FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY
- PLIERS-CUTTERS
- ALIGNMENT TOOL
- CERTIFICATE OF MERIT
- VALUABLE DISCOUNT CARD
- WRENCH SET

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of troubles in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

Unconditional Money-Back Guarantee

The Progressive Radio "Edu-Kit" has been sold to many thousands of individuals, schools and organizations, public and private, throughout the world. It is recognized internationally as the ideal radio course.

By popular demand, the Progressive Radio "Edu-Kit" is now available in Spanish as well as English.

It is understood and agreed that should the Progressive Radio "Edu-Kit" be returned to Progressive "Edu-Kit" Inc. for any reason whatever, the purchase price will be refunded in full, without quibble or question, and without delay.

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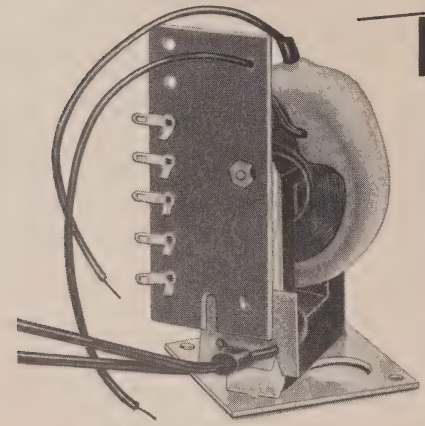

here is PROOF!

This table of STANCOR'S exact replacement flyback coverage is based on an actual count of the models listed in the latest STANCOR TV Replacement Guide. *Only exact replacement flybacks are listed.* These percentages *do not* include flybacks that require chassis or circuit alteration. Actually, true coverage is even higher than these figures indicate since STANCOR covers *all* of the most heavily produced models.

Manufacturer	Stancor EXACT Repl. Flybacks	COVERAGE
Admiral	9	83%
Airline	11	81%
General Electric	14	95%
Olympic	4	83%
Philco	12	90%
RCA	11	91%
Silvertone	11	74%
Zenith	14	97%

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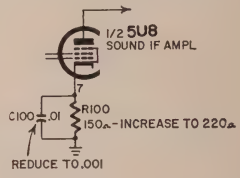
STANDARD AMERICAN SUPPLIERS, INC. Midget Dept. RE-7 One Park Ave., New York 16, N.Y.

This grid resistor stunt is not new. It was used many years ago to bypass the use of the Neutrodyne and other patent circuits designed to prevent oscillation in tuned rf stages. — *Eugene M. Funk*

SYLVANIA MODEL 614

Between distortion and buzz, the set's sound was rotten. A scope showed the trouble was caused by oscillation in the audio if amplifier which was overloading the detector and permitting buzz to come through.

The cure was comparatively simple. Resistor R100 and capacitor C100 (the



sound if amplifier cathode resistor and bypass, respectively) were replaced. The .01-μf capacitor was replaced with a .001-μf unit and the 150-ohm resistor gave way to 220 ohms. The increased bias caused by this change lowered the gain while the reduced bypass capacitance helped degenerate the stage further.—*Louis Sherman*

ZENITH Y2229R

The set was brought to the shop when our outside man couldn't clear up a weak picture. We soon tracked the lack of signal strength to the detector. We were getting a dim picture (weak contrast), and the agc didn't seem to perform properly.

With this ailment, lack of contrast and agc, breaking away one end of the 1N64 crystal cut the signal off entirely, so we naturally assumed a new crystal was needed.

But before soldering it in place and just to make sure, we clipped the new crystal in place, using a pair of 12-inch test leads. The trouble was still there, and we spent the next 4 hours hunting for more trouble and wondering about the crystal.

Finally we soldered the new crystal in place, with its *short* leads and the set worked OK! Seems like the extra inductance of the long test leads we used for a temporary try made the new crystal act as if it, too, were faulty.— *Harry J. Miller* END

CIVIL SERVICE EXAM

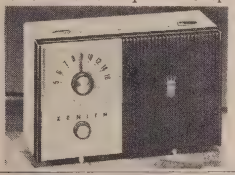
Examinations for electronic technician jobs at $3,175–$7,570 a year, involving installation and maintenance of computers, detectors, test and communications equipment in the Washington, D. C., area, have been announced by the US Civil Service Commission. No written test is required, but applicants must show they have had adequate experience, training or education. Information and applications are available from most postoffices and the Civil Service Commission, Washington 25, D.C.

new Devices

DIODE RADIO. *Pollak's Rocket.* Single diode detector. No batteries needed. Rod in nose of Rocket serves as permeability

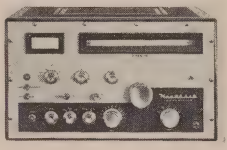
tuner. Antenna connection with alligator clip.—**Standard American Suppliers Inc.,** 1 Park Ave., New York 16, N. Y.

CORDLESS RADIO. *Royal 900* table model. All-transistor feedback circuit. 4-inch speaker. 500 mw undistorted power output.



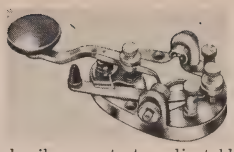
Uses 8 C flashlight cells. Battery life 300 playing hours. Venier tuning. Earphone jack. 4 x 7 x 3 inches.—**Zenith Radio Corp.,** 6001 W. Dickens, Chicago 39, Ill.

HAM TRANSMITTER KIT. *Heathkit Apache, model TX-1.* 150-watt phone, 180-watt CW input. 80-, 40-, 20-, 15- and 10-



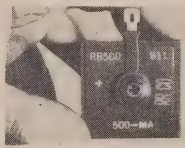
meter bands. Can be used with external single-side band adapter. Low-distortion modulator has two 6CA7/EL-34 tubes in push-pull. Time-sequence keying provides chirpless break-in CW operation.—**Heath Co.,** Benton Harbor, Mich.

TELEGRAPH KEYS. *Model MS-428* (illustrated). "Brass-pounder's key." Polished brass, 3/10-



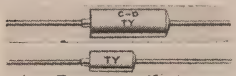
inch silver contacts, adjustable ball-bearing pivots, circuit-closing switch. *Model MS-319* has chrome- and nickel-plated parts, adjustable contact clearance and spring tension. Also *MS-436* high-frequency buzzer and *MS-435* semi-automatic "bug."—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

SELENIUM RECTIFIERS. 6 new types for radio and TV set replacement. Smaller than conventional cells of same current rating. Rated at 130 volts ac, cover all current ratings to 650 ma. *RR500* (illustrated): a 500-



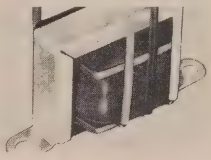
ma unit with 1.6-inch square cells.—**Radio Recepter Co. Inc.,** 240 Wythe Ave., Brooklyn 11, N. Y.

TANTALUM CAPACITORS. *Solitan series.* For transistor application in computer and military circuits. Solid electrolyte. Miniaturized (60 μf at 6 volts or 6 μf at 35 volts dc working have 3/16-inch diameter, 7/16-inch length). Wider useful temperature characteristics. High stability. Free from corrosion, vibration effects, shelf-life



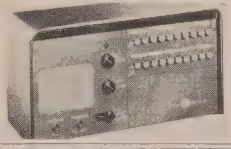
and service-aging deterioration.—**Cornell-Dubilier Electric Corp.,** South Plainfield, N. J.

TRANSISTOR TRANSFORMERS. *Stancor model TA-15* input



transformer. *TA-16* driver transformer. *TA-17* modulation transformer.—**Chicago Standard Transformer Corp.,** 3501 Addison St., Chicago 18, Ill.

INTERCOM CONTROL UNIT, *Knight 93 SX 056.* Converts PA to intercom and paging system. Requires no ac power, has volume control, talk–listen–program



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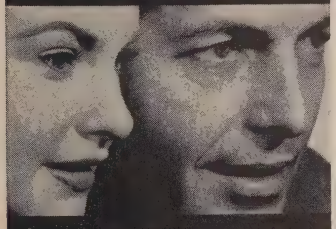

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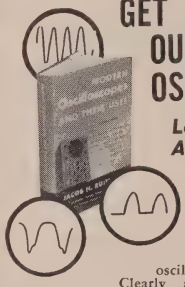

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switch, all-call switch. Speaker–microphone. Can serve 20 stations, or 40 with accessory switch panel adapter *No. 93 SX 057*.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80.

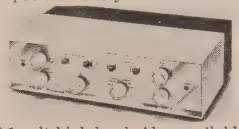
SPEAKER SYSTEMS. *Debonaire models S-3, S-4* and *EN-1215* enclosure. Decorator-styled lowboy high-fidelity enclosures with 3-

element 12- or 15-inch speaker systems. *S-3* uses 12-inch woofer, H-600 reciprocating flare horn with T-30 driver, UXT-5 super tweeter. *S-4* has 15-inch Diffaxial speaker, H-600 and Hypersonic T-50 driver. *EN-1215* is lowboy enclosure only.—**University Loudspeakers Inc.,** 800 So. Kensico Ave., White Plains, N. Y.

REAR-SEAT SPEAKER. *Satellite kit.* 6 x 9- or 5 x 7-inch speaker, chrome-plated switch plate and grille, 3-position slide

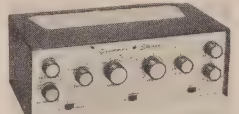
switch. All hardware.—**Oxford Components Inc.,** 556 W. Monroe St., Chicago 6, Ill.

STEREO PREAMP KIT. *Model SP-6.* Inputs for tape deck and magnetic cartridges. 2 outputs for each channel. Function-selector switch adjusts for stereo, reversed stereo or monaural. Intermodulation distortion less than 0.25% at full gain. Hum below 70 db. Maximum output levels 3 volts at cathode-follower outputs, 10 volts at tape outputs. Input sensitivity 2 mv low level,



0.1 volt high level. Also available wired.—**Arkay Kits,** 120 Cedar St., New York, N. Y.

STEREO PREAMP. *Model 208.* 2 independent channels for each



of 5 inputs. Ganged selector, turnover, rolloff, volume, bass and treble controls. Either channel may be used as monaural preamp, driving both power amplifiers. Feedback circuits, dc filaments.—**Grommes, Div. of Precision Electronics Inc.,** 9101 King St., Franklin Park, Ill.

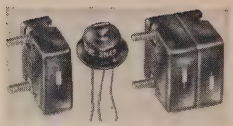
LINEAR AMPLIFIER. *LA-400-C Kit.* 75–10 meters. Metering circuit reads rf voltage input, plate current, rf amps output.

400-watt peak envelope power input with 20 watts drive. Low-impedance input, pi-network output, with 4 modified 1625 tetrodes. TV interference suppression.—**P & H Electronics Inc.,** 424 Columbia, Lafayette, Ind.

MOBILE AMPLIFIER. *Knight KN-3125.* 25 watts. Operates from 6 or 12 volts dc or 110 ac. Inputs for 2 microphones and 2

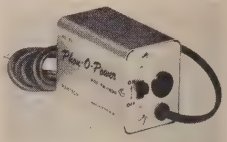
record players. Phono fader. Response at full output, ±2db from 40–20,000 cycles. Hum level 75 db below stated output. *Model KN-3025* is identical, less record player.—**Allied Radio Corp.,** 100 No. Western Ave., Chicago.

ERASE HEAD. Type S (transistor shown for size comparison). Especially suited for use with transistor circuitry, 55-db era-



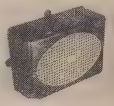
sure with ½-watt input. Easily ganged for 2- and 4-track erasure. — **Michigan Magnetics Inc.,** Vermontville, Mich.

HI-FI ACCESSORIES. *Vantron Phonobooster model PB-1000* is fully transistorized miniature



preamp. *Phon-O-Power model PW-1000* (illustrated) provides hum-free power for *Phonobooster,* eliminating all other power connections to main amplifier.—**Electronics Div., Van Norman Industries Inc.,** 186 Granite St., Manchester, N. H.

LOW-COST BAFFLE, *Universal.* Accepts round and oval speakers up to 6 x 9 inches. Unbreakable styrene, 10¾ x 8 x 3⅝ inches in blond, gray and mahogany, for extension speaker and PA



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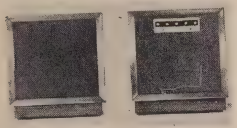
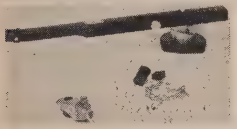
purposes.—**Saxton Products Inc.,** 1661 Boone Ave., New York 60.

STEREO CONSOLE. *Model SA-1032.* Speaker–amplifier system for conversion of monaural hi-fi systems. Incorporates new *model AA-903B* amplifier–preamp. Con-



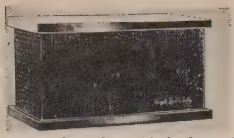
tinuous output 16 watts (32 watts peak). 4-speaker system has 12-inch woofer, 8-inch lower mid-range speaker, 6-inch upper mid-range, 3-inch tweeter. In 4 finishes.—**Pilot Radio Corp.,** 37-08 36th St., Long Island City, N. Y.

STEREO ARM KITS. *Model KT-12* (12-inch), and *KT-16* (16-inch). Identical to Audax monaural arm kits, but wired to accept both stereo and monaural cartridges. *Model KTS* converts monaural kits for stereo, includes cartridge housing, lead



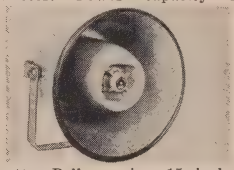
wire, gauge tube, 2 aluminum spacers.—**Audax Inc.,** 38-19 108th St., Corona 68, N. Y.

MINIATURE SPEAKER SYSTEM, *the Minstrel.* Air chamber serves as phase-matching trans-



former. 9 x 9 x 16 inches. 10 watts. Response 50–15,000 cycles. Efficiency 7% measured, with 3 octaves of white noise. Impedance 4 ohms. Mahogany, walnut, blond or ebony.—**Telematic Industries,** 251 Lee Ave., Brooklyn 6, N. Y.

COAXIAL SPEAKER. *Projector model WT-6.* Weatherproof unit houses 2 individual drivers with separate horns and crossover. High-efficiency woofer has folded exponential horn. Wide-angle tweeter. Power capacity 15

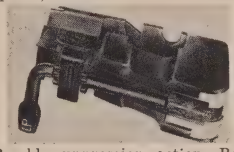


watts. Bell opening 15 inches. Depth 11 inches.—**Atlas Sound Corp.,** 1449 39th St., Brooklyn 18, N. Y.

STEREO CARTRIDGE, *Binofluid.* Compatible with monaural and stereo discs. Flat response 20–15,000 cycles with rolloff at 14,000. Lateral and vertical compliances of 3.5×10^{-6} cm/dyne. Optimum stylus pressure 4–6 grams. Available mounted in

Fonofluid 12- or 16-inch transcription arm.—**Ronette Acoustical Corp.,** 190 Earle Ave., Lynbrook, N. Y.

TURNOVER STEREO CARTRIDGE. *Models 8T-4S, 8T-4SD* and *8T-4D.* Ceramic, for all speeds, stereo or monaural.



Rumble-suppression action. Response smooth from 20–20,000 cycles. Output 0.3 volt. Compliance 2×10^{-6} cm/dyne. Recommended load 2 megohms/100 $\mu\mu$f (each channel). Tracking pressure 6 grams. Weight 7.5 grams. Channel isolation 20 db. Available with dual sapphire, dual diamond or sapphire and diamond styli (replaceable).—**Sonotone Corp.,** Elmsford, N. Y.

REPLACEMENT CARTRIDGES. *Models 1* to *32.* New line of 32

units designed to replace 80% of cartridges. Simplified needle changing. Built-in needle guard. Required needle number printed on cartridge. Chart identifies correct replacement. — **Jensen Industries,** Forest Park, Ill.

HI-FI CARTRIDGE. *Model 230 Micro-7,* production version of experimental *Model XP-3.* 0.7-

mil diamond stylus. Air damping, high vertical and lateral compliance. Tracking force as low as 1 gram. Output 5 mv.—**Fairchild Recording Equipment Co.,** 10-40 45th Ave., Long Island City, N. Y.

AUTO ANTENNA. *Super "8"* adjusts up to 35°. 4 telescoping sections extend to 57 inches. 54-

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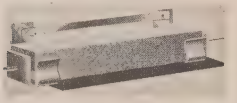

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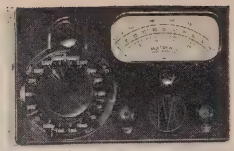

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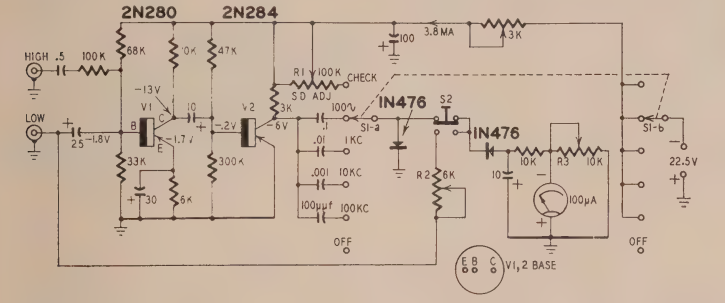
This frequency meter uses only two transistors and covers 10–100,000 cycles for any input signal larger than 0.4 volt. The maximum direct LOW input voltage is limited to 5, and the input impedance is low—about 1,000 ohms. A HIGH input is also provided. It includes a 100,000-ohm series resistor, so the maximum input voltage it can accept is about 500. The two inputs cover practically the entire voltage range for usual signals.



The first stage amplifies the signal to several volts, and with a large amplitude input insures some degree of clipping. The second stage has a high quiescent collector current and is very near saturation. It limits the signal coming from the first stage and transforms it into a constant-amplitude square wave.

This square wave is integrated across a capacitor, which charges to a value directly proportional to frequency. The integrated voltage is rectified and applied to a 100-μa meter which is directly calibrated in frequency.

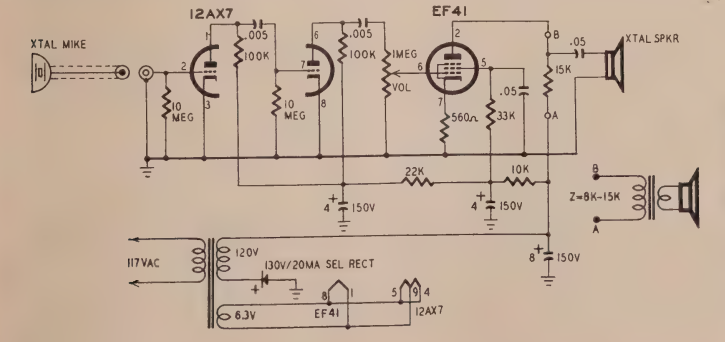
Four integrating capacitors are needed to cover the frequency range in four decimal scales: 100, 1,000, 10,000, and 100,000 cycles. The range switch has six positions. First is OFF. The following four are the ranges. The last one is CHECK, to check the battery. Control R1, nominally 100,000 ohms, must be adjusted so that the microammeter reaches full deflection for a new battery.

Another facility is provided by push-button S2. By pressing on it, the voltage-measuring circuit is connected directly to the LOW input and measures the input signal voltage. Resistor R2 is adjusted for the microammeter to reach full deflection for an input voltage of 5.

To calibrate the unit apply line voltage to the HIGH input and adjust resistor R3 to read 60 on the meter, with the range switch set on 100 cycles. The calibration is then correct for the first three ranges. However, on the fourth range, 100,000 cycles, parasitic capacitances may come into play, and this range would be best calibrated point by point, using an audio generator for reference. The four range capacitors should be precision elements for high accuracy. The circuit originally appeared in *Funkschau, 7-57.—A. V. J. Martin*

ELECTRONIC BABY-SITTER

Crudely speaking, an electronic baby-sitter is nothing more than a low-fi hi-gain audio amplifier, and there would be little reason to describe a new one if it did not have some special advantage. In this circuit, originally described in *Funkschau* (Germany), February, 1957, the advantages are small size and high sensitivity, as well as economy both in parts and operating costs.



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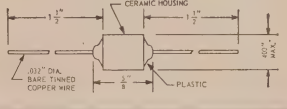
APPROX. RECTIFIER VOLTAGE DROP	.2	.2
MAX. OPERATING TEMP.	100°C	100°C
MAX. SURGE CURRENT (AMPS)	30	20
MIN. SURGE LIMITING RESIS. (OHMS)	7.5	10

DIMENSIONS



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The diagram shows a crystal microphone driving a 12AX7 double triode—the triode sections are cascaded. The cathodes are grounded, and grid bias is obtained by the grid current flowing through the 10-megohm grid resistors. This insures high gain, and the resulting distortion is more than tolerable when the signal to be amplified is the wailing of a baby.

The output stage uses a low-power pentode. A 6AU6 can be used in place of the indicated EF41. Use a 150-ohm cathode resistor with the 6AU6. It drives a small crystal speaker. However, a small dynamic speaker can be used, and may be more easily available. Its transformer should have a primary impedance of about 8,000–15,000 ohms. This is not a critical value. The transformer's primary replaces the 15,000-ohm resistor.

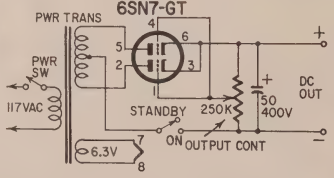
The B-plus voltage is provided by a half-wave transformer and a 130-volt, 20-ma selenium rectifier. The transformer also provides 6.3 volts for the heaters. Total power consumption is only 10 watts.

In use, the microphone is placed in the baby's room. It is connected to the amplifier through any convenient length of shielded wire. The amplifier and speaker are installed in the parents' room, and the volume control set for the required sensitivity.—*A. V. J. Martin*

VARIABLE BIAS SUPPLY

It is useful to have a simple variable low-current power supply on hand, especially for use in circuit development where it may be necessary to find that the optimum bias voltage for a particular circuit.

Such a unit is shown in the diagram. It is an ordinary full-wave rectifier circuit, but with the difference that it



uses a 6SN7-GT dual triode as a controlled rectifier. A 250,000-ohm potentiometer controls the grid bias and thus the conductance of the tube. This varies the output voltage.

Building the unit presents no special problems. Most of the parts are probably in your junkbox. Better regulation and current capacity can be obtained by using other tubes. 6BL7-GT, 6AS7-G or triode-connected 6Y6-G's are examples.—*Charles Erwin Cohn* END

CORRECTION

The diagrams for Figs. 2 and 3 are transposed in the article "Spot-O-Matic" in the June issue. The diagram of the basic bridged-T is on page 98 and the variable frequency control circuit is on page 97.

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SOLDERING-IRON HOLDER

After inadvertently laying a hot soldering iron on my workbench a couple of times while concentrating on a delicate repair job, I began to look around for a simple solution in the form of a soldering-iron holder that would let me replace the iron without lifting my attention from the work that happens to be at hand.

I finally hit on it. I happened to have several old PM speakers around. Selecting one with a strong magnetic field, I cut out the metal between the cone-holding flange, removed the old cone, voice coil, and output transformer mounting strip, and placed the speaker face down on the bench.

I now have a holder that practically takes the iron from my hand whenever I lay it down in its vicinity. I have learned to give the iron a quick quarter twist to free it of the magnet when picking it up to use again.—*Robert L. Marcon*

SALVAGING TRANSISTORS

Many of us have transistors with one or more broken leads around the shop or basement lab. Usually, when a lead breaks off flush or close to the case, the transistor is considered valueless. However, I have developed a method that will save many of these units.

Take a 2- or 3-inch length of tinned No. 26 or 28 wire. Form a drop of

solder on one end of this wire. Apply the soldering iron an inch away from the wire's end and allow the drop of molten solder to touch the stub of lead

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☐ Fully wired, ready for use. Reg. $5. Sep. vol., tone controls. Lowest price ever! $2.99

☐ TUBES, $1.91 EXTRA

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Including Phone and Batteries!

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- ☐ 70 TUBULAR CONDENSERS. 3 lbs.
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- ☐ 1 MINI-METER 0-6A, AC. 1 lb.
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HOW TO ORDER Check items wanted. Return entire ad w/check or M.O. including sufficient postage; excess returned. C.O.D. orders, 25% down; rated, net 30 days. Print name, address, amount money enclosed, in margin. (Canada postage, 45c 1st lb., 28c ea. addl. lb.) EXPORT ORDERS INVITED.

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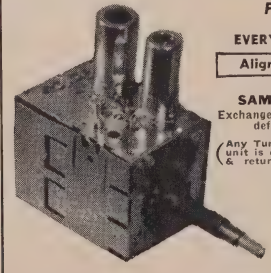

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Including All Worn Parts (except tubes, where needed)

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Just forward defective Tuner prepaid. Complete with good tubes and all damaged parts; quote make and model.

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Suppliers of rebuilt TV Tuners to leading manufacturers, technicians & service dealers, coast to coast.

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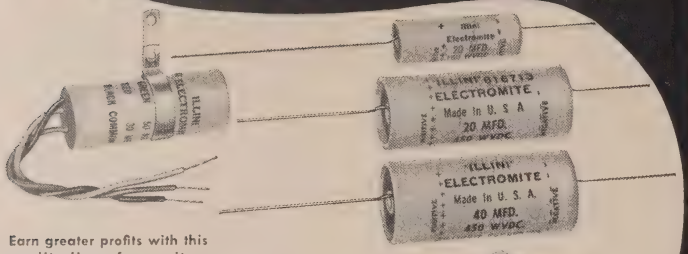

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Available in variety of sizes with flexible leads or tinned pigtail leads. Attractively packed 10 to colorful display box. One full year unconditional guarantee. *Write for catalog.*
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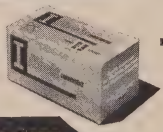

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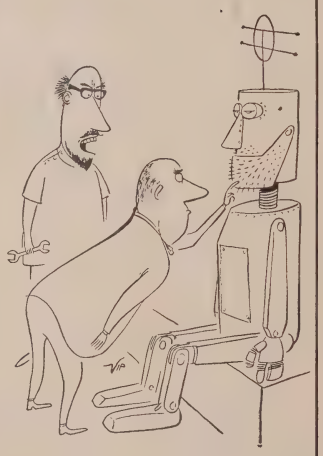


"What do you mean, 'He looks like a bum.' Those happen to be JENSEN NEEDLES, sir!"

at the transistor. Remove the iron and hold steady until set.

This is one operation where the use of paste flux is tolerated. However, after the job is done, wash well with alcohol or carbon tetrachloride.

The pliers serve a twofold purpose. They hold the lead in position and rapidly dissipate residual heat after the soldering iron is removed.—*John Bachtell*

SUPPORT FOR TV CHASSIS

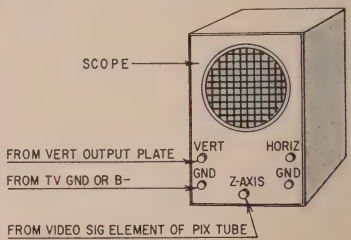
When pulling the chassis of a table-model TV receiver, I rest the rear of the chassis on a ¾ x 2¾ x 24-inch piece of plywood. This keeps the front end of the chassis and the picture tube from tilting upward and jamming against the inside top of its cabinet.

This same strip of wood is also used when replacing a chassis in its cabinet. It keeps the chassis lined up and helps to keep you from bashing the picture tube against the rear of the cabinet.—*I. G. Golden*

TV PICTURES ON SCOPE

Sometimes while repairing a TV set it might be advantageous to obtain a picture on the scope screen without using the horizontal deflection circuits. This is a simple matter when the scope is connected as shown in the diagram.

Adjust the scope's vertical gain control for convenient deflection. The scope's sweep oscillator is used for



horizontal deflection and is set at approximately 15,750 cycles or adjusted so that a picture is brought into view.

The picture on most scopes will be negative if the control element of the picture tube is its cathode and positive if the grid is the control element.

Wth the negative picture, a one-tube amplifier with a resistive plate load can be used to shift the phase 180° and give you a positive picture.—*Sam H. Garner*

TAPE-RECORDING HINT

To identify tape recordings, I jot down the titles of the selections on strips of Labelon "write-on-it" plastic labeling tape and stick them to the magnetic-tape reels and cartons. For recordings made at 7½ ips I use blue tape; for 3¾-ips recordings I use red tape. The plastic labels are durable and the writing remains clearly legible despite constant handling of the reels. The tape can be purchased from most radio mail-order houses and local distributors.—*J. C. Alexander* END

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CATHODE RAY TUBE SPECIALS

ONE YEAR GUARANTEE

G.E.	Type	STAN BURN	G.E.	Type	STAN BURN
$15.80	10BP4	$10.00	24.75	17LP4	$18.00
19.10	12LP4A	13.95	37.00	19AP4A	24.00
	12QP4	11.50	28.35	20CP4A	18.95
20.35	12UP4	15.00	33.50	20CP4B*	21.95
20.75	14CP4	13.75	36.00	21AP4	25.00
	15DP4	14.50	29.75	21EP4A	20.15
33.75	16AP4	18.50	34.85	21EP4B*	23.25
32.20	16DP4A	15.25	30.90	21FP4	21.15
33.75	16GP4	18.75	37.00	21MP4	26.25
23.50	16KP4	15.75	29.75	21YP4	22.00
28.40	16KP4A*	18.75	34.85	21YP4A*	23.00
31.50	16LP4A	16.25	28.30	21ZP4	21.00
31.50	16WP4	16.25	33.60	21ZP4B*	24.00
23.50	17BP4	15.75	100.00	24AP4	56.00
28.40	17BP4B*	18.75			(6 mos. guar.)
30.75	17CP4	20.50	48.40	24CP4A*	38.00
33.90	17GP4	21.50	50.00	24DP4A*	39.00

*ALUMINIZED—INQUIRE FOR ANY TUBE TYPE NOT LISTED. STAN-BURN CRT TUBES RCA LICENSED—MFD. BY LINCOLN. All orders of 6 or more STAN-BURN CRT are subject to additional 10% discount. PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

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Diamond needles reduce record wear and needle noise thus retaining full frequency response and tonal qualities of your records for a longer period of time.
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GARRARD RC-88 4 speed changer.... 53.41
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FREE wood mounting base, record wiping cloth and 45 RPM spindle with all orders for Collaro and Garrard changers, with this ad.

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SONOTONE cartridge, flip-over.....$2.98
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WOOD MOUNTING BASE for V.M. or Monarch $3.95
MOUNTING BOARD unfinished for V.M. or Monarch $1.50
NEW GENERAL ELECTRIC HI-FI VARIABLE RELUCTANCE CARTRIDGE. Replaces discontinued RPX050 type. Full range reproduction 20-20,000 cycles. Four gram tracking force for minimum record and stylus wear.
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KITS! We stock the following manufacturers' complete line of kits—see reference pages.

EICO see pages 23-24
HEATHKIT see page 94
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All domestic orders will be shipped prepaid. Send us your list. Order by Mfr. and Model No. of item.

$20 WORTH OF ELECTRONIC PARTS IN GRAB-BAG consisting of: Porcelain sockets, coils, speaker, transf, resis, cond. ONLY.....$1.98 (plus 50c postage)

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Complete line of T.V. & Radio receiving tubes, coils, transf., controls, antennas & accessories—No Minimum Order—DEALER DISCOUNTS! Thousands of satisfied Hi-Fi enthusiasts and dealers will vouch that STAN-BURN GIVES THE BEST DEAL POSSIBLE!
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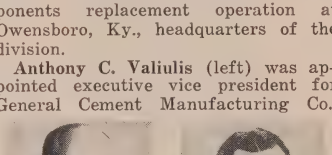
Business and People

John T. Thompson joined Raytheon Manufacturing Co., Waltham, Mass. as manager of the newly formed Distributor Products Div. He comes to Raytheon from General Electric, where he was manager of distributor sales for the Electronic Components Div.

Capt. Roland A. Reuther, USN (Ret.) was promoted to assistant to the vice-president of Cleveland Institute of Radio Electronics, Cleveland, Ohio. He had been active in the school's West Coast sales operation. He retired from the Navy last year after 24 years of active service.

Gordon E. Burns, former regional equipment sales manager for the General Electric Receiving Tube Dept. in Chicago, was promoted to distributor sales manager, heading the G-E receiving tube and electronic components replacement operation at Owensboro, Ky., headquarters of the division.

Anthony C. Valiulis (left) was appointed executive vice president for General Cement Manufacturing Co.,



Rockford, Ill., and **Russell D. Gawne** was elected vice president in charge of sales. Valiulis has been with the company for 18 years in various capacities, most recently as plant manager of the main plant. Gawne had been general sales manager for the last three of his 17 years with the company.

Aurel G. Petrasek is now manager of merchandising, receiving tubes, RCA Electron Tube Div., Harrison, N. J. He had been manager–merchandising, market planning, kinescopes.

win a dream trip for two to the

RK-22

BRUSSELS WORLD'S FAIR!

win other exciting prizes... in the big, new Rek-O-Kut contest!

Rek-O-Kut's exciting, new contest is a music-lover's delight! You can win a trip for two to the Brussels World's Fair via Sabena Belgian World Airlines... magnificent Rondine turntables... and turntable arms... just by listening to a Rek-O-Kut demonstration. Simply stop in at your high fidelity dealer, ask him to demonstrate high fidelity reproduction on a Rondine turntable, and fill out an entry blank. There are no puzzles to solve—no jingles to write—no coupons to clip—nothing to buy! You'll be eligible for one of the big contest prizes... and you'll have enjoyed music reproduction at its finest—on a Rondine! Prices from $59.95.

Selected for display at the American Pavilion, Brussels World's Fair!

For the high fidelity dealer nearest you, write:
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38-19 108th Street, Corona 68, New York

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I. J. Saltzman, Globe Sound Service, Jamaica, N.Y., experienced commercial sound engineer, says: "On side by side comparison test, the CJ-44 outperforms them all."

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CJ-44

Shown with GB-1 Universal Mounting Bracket

Complete with "Acousti-Match" Built-in Driver Unit

List $72.50

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A wide-angle, all-purpose, all-weather Public Address Speaker, complete with integral high-power super-efficient "Acousti-Matched" driver unit. "Acoustic-Matched" means "Controlled Response" within the frequency limits most useful in P. A. and high level music reproduction. "Controlled Response" offers conversion efficiency never before obtainable in high-powered speakers. "Controlled Response" results in *smooth* reproduction — free from peaks which so often create and sustain acoustic feedback.

The CJ-44 conserves costly amplifier output power — fewer speakers do a complete job. The speaker horn is easily rotated for horizontal or vertical dispersion patters.

The CJ-44 is the only high-powered P. A. speaker that can be equipped with the new Atlas Universal Mounting Bracket, permitting quick and secure directional adjustment on both planes. Simple to make a horizontal or vertical adjustment as a final "touch-up" to the installation.

The CJ-44 is designed for the "tough jobs." No gimmicks, no fluffs, no wild claims — just a reliable super-efficient speaker for all applications.

Input Power:	30 watts constant 50 watts peak
Input Impedance:	16 ohms
Response:	150-9,000 cps
Dimensions;	Bell 23" x 13"; Over-all length 19"
Net Weight:	16 lbs.

Write for free Catalog 57.

ATLAS SOUND CORP.

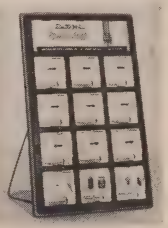
1449-39 St., Brooklyn 18, N. Y.

Atlas Radio Ltd., Toronto, Canada

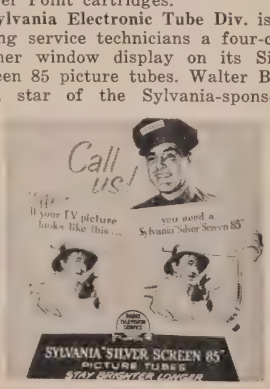
Marvin Grossman, sales manager of H. H. Scott Co., Maynard Mass., organized and taught a course on "Exploring Electronics" for pre-high-school students, in conjunction with the Boston Museum of Science. Gernsback Publications cooperated through the donation of supplementary literature. Grossman is shown explaining a basic radio experiment to three eager students.

Lee Schweitzer was appointed sales manager of Coleman Tool & Machine Co., Amarillo, Tex. The company concurrently announced a 50% expansion of its office and warehouse facilities.

Electro-Voice Inc., Buchanan, Mich., designed a new merchandiser for its Power Point phono cartridges. At the same time the company announced a new packaging program for the cartridges. The new case of translucent plastic displays the cartridge in a jewel box and comes in 12- and 6-pack cartons for dealers. A cash-value stamp dealer promotion is another phase of the company's promotion drive on Power Point cartridges.



Sylvania Electronic Tube Div. is offering service technicians a four-color flasher window display on its Silver Screen 85 picture tubes. Walter Brennan, star of the Sylvania-sponsored



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CASH PAID! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose, receiving, TV types, magnetrons, klystrons, broadcast, etc. Also want military & commercial lab test and communications gear. We swap too, for tubes or choice equipment. Send specific details in first letter. For a fair deal write, wire or telephone: BARRY, 512 Broadway, New York 12, N.Y. Walker 5-7000.

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STEREO TAPE RENTALS. For the very best at lowest prices. Write CALIFORNIA TAPED MUSIC ASSN., 1971 Cordilleras Road, Redwood City, Calif.

START A FAST GROWING, money making business. Operate a self-service tube tester route spare or full time. No selling. Stores make money for you every open hour. Send for FREE booklet describing this proven business. CENTURY ELECTRONICS, 111-J Roosevelt Ave., Mineola, N. Y.

LABORATORY QUALITY equipment and Military Surplus Electronics bought, sold. ENGINEERING ASSOCIATES, 434 Patterson Road, Dayton 9, Ohio.

DIAGRAMS FOR REPAIRING RADIOS $1. Television $2. Give make, Model. DIAGRAM SERVICE, Box 672-RE. Hartford 1, Conn.

FREE INFORMATION on printed circuits. CIRCUIT LABORATORIES, Box 52E, Norwalk, Conn.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. HAZELTON INSTRUMENT Co., 128 Liberty Street, New York, N.Y.

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5-inch TV Test Tube. Model 5FP7. Brand-new, using an improved plug-in harness converter. See article "Economy Test Tube," Radio-Electronics, March, 1958, page 57. Essential for vertical chassis-non-ion. Guaranteed. $3, postpaid. LION PRODUCTS, Box 205, Brooklyn 15, N. Y.

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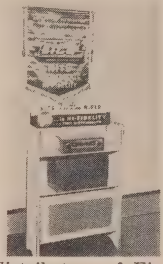
TV show "The Real McCoys," is featured.

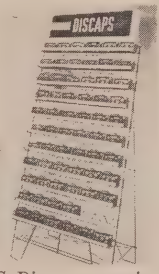
Heath Co., Benton Harbor, Mich., which formerly sold its Heathkits by mail order only, will now sell through dealers in key market areas as well. The retail price at dealers will be slightly higher than the mail-order.

Electronic Instrument Co., Long Island City, N.Y., has come up with a new display stand as part of a package



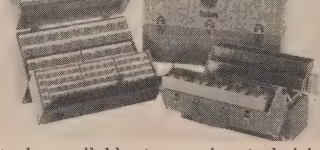
deal for distributors of Eico hi-fi and test equipment in kit and wired form.

P. R. Mallory & Co., Indianapolis, Ind., has given service technicians the opportunity to select from a wide range



of its RMC Discap ceramic capacitors from a self-service display.

General Electric Receiving Tube Dept., Owensboro, Ky., has made a new two-tone service case for tubes and



tools available to service technicians through its distributors.

Supreme Publications, Highland Park, Ill., is offering distributors a re-

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Electronic Technician, April 1958

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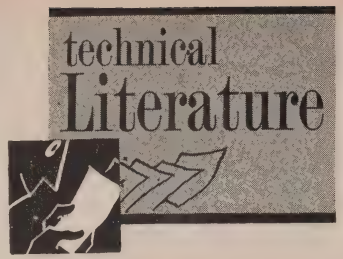

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

TUBE TIPS, by Bud Tomer. The first 12 issues in this series have been bound into one volume *(PA-225)*, with sections on tube checkers, uhf tubes, new type TV tubes, design and construction features, the effects of military and industrial tube demands, definitions of tube characteristics. — **Available through CBS-Hytron distributors. 50c.**

TANTALUM CAPACITORS engineering bulletin gives electrical characteristics of *TAK* slug capacitors with graphs showing capacitance and impedance stability from − 55° to 100°C.—**Pyramid Electric Co.,** 1445 Hudson Blvd., North Bergen, N. J.

TUBE DATA BOOK. Approximately 1,000 television and radio receiving-tube types are listed, with more than 50 pages of electrical and mechanical operating characteristics and other data in the new *Receiving Tube Data Book.* Basing diagrams, type information on same page.—**Raytheon Manufacturing Co.,** 55 Chapel St., Newton, Mass. **50c.**

TRANSISTOR COURSE for home study is outlined in descriptive folder *PA-176.* Complete table of contents for the 10-lesson course and an explanation of the "learn by doing" approach are included.—**CBS-Hytron Advertising Service,** Parker St., Newburyport, Mass.

TELEVISION ACCESSORIES described in a four-page catalog: picture-tube boosters and rejuvenators, remote-control extension speaker, CRT substitution tester, dual speaker switches and volume control, antenna selector switch ics, 134 Nassau Rd., Roosevelt, N. Y.

HI-FI CATALOG contains complete specifications, descriptions and prices of the manufacturer's audio, TV and hi fi components, kit or factory-wired.—**Arkay Inc.,** 120 Cedar St., New York 6, N. Y.

CONSTRUCTION MANUAL for photoelectronic relay *kit KT-133.* Describes in detail the building and applications of a single-tube relay which can be used to activate burglar alarms, door-opening motors, counters, etc. Complete specs included.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

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TUBE PRICE CHART, 11 x 14 inches, designed for wall mounting, shows industry-recommended retail prices for 839 tubes used in radio, TV and high-fidelity applications.—**Tung-Sol Electric Inc.,** 95 Eighth Ave., Newark 4, N. J.

SINGLE-SIDEBAND SPECTRA are discussed with illustrations, graphs and formulas in Vol. 1, No. 3 of *The Panoramic Analyzer.* Testing techniques with spectrum analyzers are detailed in this bulletin designed to aid those using or designing single-sideband equipment. —**Panoramic Radio Products Inc.,** 514 So. Fulton Ave., Mount Vernon, N. Y.

ISOPHASE SPEAKER is described in nontechnical terms with good humor by radio and television personality Jean Shepherd in an 8-page booklet, *Isophase, a New Kind of Sound.*—**Pickering & Co. Inc.,** Plainview, N. Y.

CAPACITOR REPLACEMENT *Manual K-301* for auto radios gives a complete listing of *Atom* and *Twist-lok* electrolytic replacement capacitors for all car radios manufactured from 1946 through 1957. Replacements are cross-referenced to the original part numbers and described by rating, part designation and price. The 8-page manual also contains a separate listing of standard capacitors.—**Sprague Products Co.,** 81 Marshall St., North Adams, Mass.

ELECTRONICS CATALOG contains 28 tabloid-size pages describing hundreds of parts, kits, components, hi-fi and radio items and test equipment.—**Olson Radio Warehouse,** 260 So. Forge St., Akron 8, Ohio.

ELECTRONIC TECHNICIAN, by Louis H. Morrison, manager, Countermeasures Dept., Wayland Laboratory, Raytheon Manufacturing Co., is one of a series of 30 *American Occupations Monographs.* The 24-page booklet describes salaries, working conditions, study requirements, opportunities and other aspects of a career as an electronic technician.—**Research Publishing Co., Inc.,** P. O. Box 245, Boston 1, Mass. $1.

APPLICATION BULLETINS on the use of semiconductors, third and fourth in a series, deal with some uses of Zener-diodes. *Vol. 1, No. 3* discusses use of Zener power regulators for improved regulation of vacuum tube heaters. *Vol. 1, No. 4* gives detailed information on high-speed electronic switching for various computers.—**Hoffman Electronics Corp.,** Semiconductor Div., 930 Pitner Ave., Evanston, Ill. END

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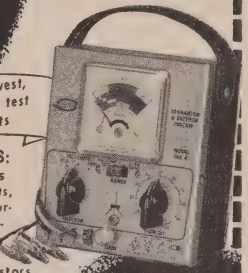

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GENERAL ELECTRIC TV SERVICE GUIDE, Vol. 3, General Electric Co., Television Receiver Dept., Syracuse, N. Y. 11 x 17 inches, 88 pages. $1.75 from G-E TV distributors and independent parts jobbers.

This guide contains schematic diagrams, replacement parts lists, model identification photos; tube, test-point and trimmer layout diagrams, waveforms, production changes and other pertinent servicing information on G-E TV receivers manufactured from 1955 to 1957. Spiral binding permits the guide to lie flat on the workbench.—*RFS*

PRINCIPLES AND PRACTICES OF TAPE AND DISC RECORDING, Vols. I and II. Audio Engineering Society. Obtainable from Sumner Hall, Lecture Series Chairman, Amityville, N. Y. 6 x 9 inches. Both volumes $5 for members, $7.50 for nonmembers.

These notes are from a series of lectures, delivered last winter to the Audio Engineering Society, discussing various problems, recent developments and modern techniques. Each volume includes 15 lectures. The notes comprise engineering data, measurements, systems layouts and references.

Volume I deals with studio problems, distortion, recording and reproducing systems. Volume II continues with specific problems relating to tape transport, noise suppression, tape duplication, stereo disk, tape editing, etc. Whether you attended the original lectures or not, these are valuable reference notes. —*IQ*

SELECTION AND APPLICATION OF METALLIC RECTIFIERS, by Stuart P. Jackson. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y. 6 x 9 inches, 320 pages. $8.

Metallic rectifiers are increasingly being used in all phases of the electronics industry. This book gives information on their fundamental characteristics and their use in many types of electronic and electrical equipment.

The text is broken into three major sections. The first covers rectifier circuits and complex loads and filters. Next comes a discussion of various types of metallic rectifiers and their uses. The last section goes into practical application and circuit.—*LS*

TAPE RECORDER MANUAL, Volume 1. Howard W. Sams & Co., 2201 E. 46th St., Indianapolis 5, Ind. 8½ x 11 inches, pages not numbered. $2.95.

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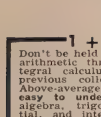

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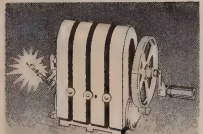

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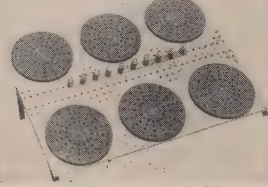

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ELECTRONIC HOBBYISTS' HANDBOOK, by Rufus P. Turner. Gernsback Library, Inc., 154 W. 14 St., New York 11, N. Y. 5½ x 8½ inches, 160 pages. $2.50.

In his usual clear and practical style, the author slants this book toward the novice and part-time technician. Old and young experimenters will find helpful guidance.

Safety and shop practice are discussed first. The building blocks of electronics—amplifiers, oscillators and power supplies—are described in separate chapters. Diagrams, parts lists and helpful instructions make it easy to follow each project. The advanced chapters show and tell how to build controls and alarms, photoelectric circuits, a stroboscope, metal locator, Geiger counter, etc.—*IQ*

COLOR TV PRINCIPLES AND PRACTICES, General Electric Co., Electronic Components Div., Owensboro, Ky. and local G-E distributors. 8¾ x 11 inches, 135 pages. $5.

Aimed at and written for the television service technician, this text presents a detailed and interesting picture of how color TV works. The reader is taken through the entire color TV story with numerous illustrations and comprehensive circuit descriptions.

Starting with a description of the nature of light, showing what happens when you add and subtract colors, the text continues through NTSC Standards, color TV receiver circuits and a look at an actual color receiver. Among the many subjects covered are: the rf tuner, the Y channel, chroma bandpass amplifier, picture-tube matrixing, static convergence, troubleshooting. If you aren't quite sure of color TV, this text should set you straight.—*LS*

MATHEMATICS FOR SCIENCE AND ENGINEERING by Philip L. Alger. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y. 6 x 9 inches, 360 pages. $6.95.

Mathematics is essential to the solution of engineering problems. This book can help bring your mathematical knowledge and skill to college level. Based on *Engineering Mathematics* by Charles P. Steinmetz, the famous scientist, it begins with easy arithmetic and progresses through trigonometry, algebra, series, calculus and differential equations.

Many examples are included to illustrate how electrical engineering calculations are made. The text advances in easy steps and should be helpful to self-study readers. Among the important topics are: slide rule, vectors, interpolation, Laplace transforms, Boolean algebra and probability. Problems and useful tables are given.—*IQ*

TELEVISION INTERFERENCE, ITS CAUSES AND CURES, by Phil Rand. Nelson Publishing Co., P. O. Box 36, Redding Ridge, Conn. 8½ x 11 inches, 56 pages. $1.75.

A complete revision of Phil's earlier editions of *Television Interference* published by Remington Rand and now out of print and unavailable. The material is divided into 10 chapters, each treating a specific phase of TVI and its elimination. Well illustrated with numerous charts, graphs, photos and diagrams.—*RFS* END

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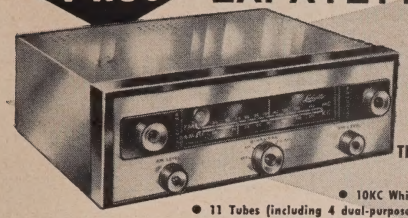

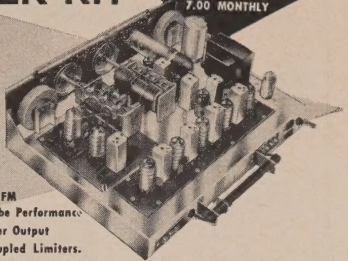

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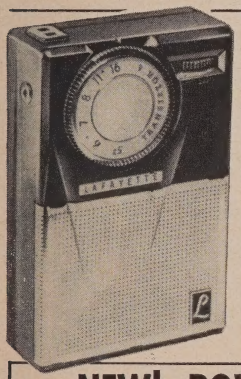

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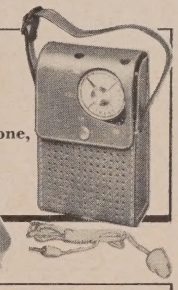

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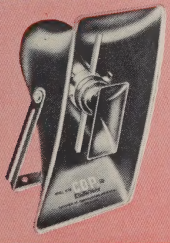

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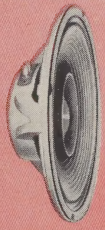

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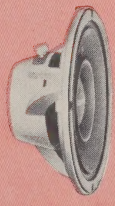

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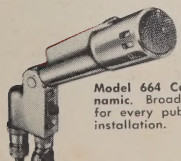

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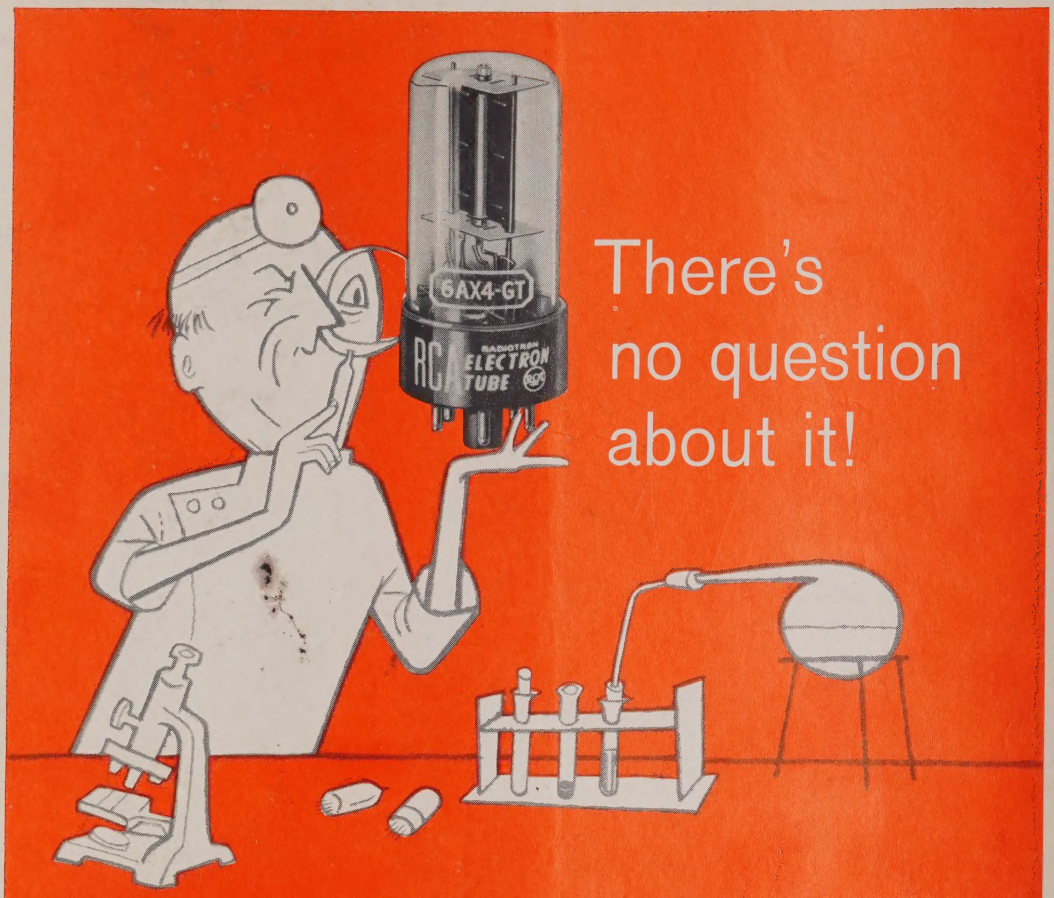

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